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Discussion of all papers is invited

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THE NEW WHEELING, W. VA., WATER WORKS[1]

By J. F. Laboon[2]

The improvements commenced with the voting of bonds in the sum of two million dollars in the spring of 1922, and, in this connection, it is interesting to note that this was one of the very few occasions where engineering advice was employed to direct the propaganda. At the writer's suggestion, the City Manager and the City Council agreed to a city-wide educational campaign, which was conducted for a period of six weeks prior to the voting day, during which period the writer served as the instrument by which data were gathered and disseminated, in every way imaginable, amongst the entire people of the City. The bonds were voted by a majority of three to one, thus ending the many failures which the City had experienced in voting bonds for purification works over a period of some fifteen years.

The improvements include the construction of new intake works, pumping station and filtration plant; the construction of force mains to connect the new waterworks with the existing force mains; the construction of 5 million gallons additional reservoir capacity; the extension of several miles of water lines; and the purchase of four private waterworks supplying the outlying districts consolidated into Greater Wheeling.

[1] Presented before the Central States Section meeting, December 5, 1924.
[2] Member of Firm of J. N. Chester, Engineers, Pittsburgh, Pa.

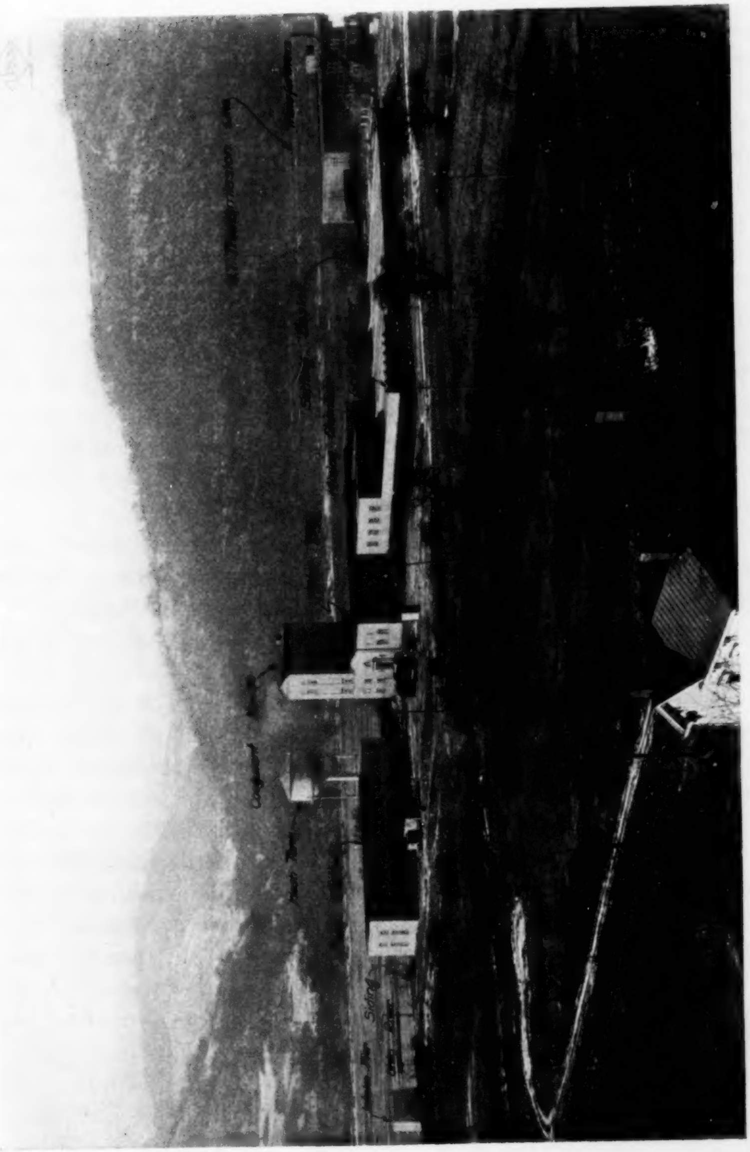
CONSUMPTION

A statement concerning the peculiar conditions surrounding the water consumption of Wheeling is necessary to portray better the reasons for constructing the new waterworks of the capacities to be stated. The water consumption of the City has had a gradual increase during the past nine years, in spite of the already existing extraordinarily high per capita consumption, with occasional years showing a decrease in the average consumption from that of preceding years, due principally to industrial depressions. The average daily consumption has risen from 13.94 million gallons for the year 1915, to approximately 17.7 million gallons for the year 1923. In 1921, the average daily consumption dropped to 15.3 million gallons due to industrial depression. In 1919, the consumption suffered a depression from the preceding and following years, which was due, no doubt, to the elimination of certain leakage prevailing at that time and discovered by means of a general pitometer survey of the entire City. The consumption has further attained daily peaks of as high as 20 million gallons and monthly averages of 19 million gallons per day. With the annexed territory to be served by the City Water Works, the maximum daily average would be increased to approximately 21 million gallons, which is slightly beyond the capacity of the contemplated filtration plant. The City fully realizes this condition, however, for it was pointed out to them, before the design of the contemplated improvements was projected, that something must be done to curtail the consumption and keep it within the capacities of the various units of the new water works improvements.

To quote from a report to the City as to the capacities of the new waterworks, the engineers stated:

A careful study of your consumption leads us to the conclusion that the daily consumption of Greater Wheeling, if all consumers were supplied from a single source with sufficient pressure, which in some cases would require boosting, would be as follows:

	gallons
As at present supplied, but with close inspection for waste	20,000,000
With all industrial and commercial consumers metered, with close inspection for waste	16,000,000
With all consumers metered, with restricted leakage in mains	12,000,000



New Wheeling, W. Va., Water Works

By adopting complete metering the City expects, ultimately, to reduce the average consumption to 12 million gallons daily, but inasmuch as it is impossible successfully to maintain meters on raw Ohio River water it becomes necessary to construct the new waterworks of sufficient capacity to supply the needs of Greater Wheeling at the outset before meters can be installed and their consequent effect be obtained. However, in order that the consumption might be reduced to such figures that the new waterworks would supply maximum demands without overstraining, it was decided to install meters on all industrial consumers since these meters are large and, therefore, less susceptible to clogging than the small domestic ones. The City, as a precaution, will make a daily inspection and reading of these meters.

While it must be recognized that a considerable portion of the entire consumption of the City is due to the industries, it would still appear that the per capita consumption is abnormally high, with an average daily per capita of 390 gallons for the old City in 1920, and approximately 400 gallons in 1922. The per capita consumption for the combined Warwood and Out-the-Pike districts which have been annexed to the City, is approximately 150 gallons, as nearly as can be determined from the meager pumping data at hand. The average daily per capita consumption for Greater Wheeling, for all water systems, in 1920 was approximately 340 gallons. It is the intention of the City to carry out the recommendations of the engineers, with respect to the curtailment of leakage and waste, and thus reduce the consumption to a point within the limits of the new improvements. This is to be followed by a systematic projection of meters, after the filtered water has been turned into the mains, in order to further reduce leakage and waste, in the hope that the consumption may be so curtailed as to forestall extension of the filtration plant and pumping station for a great many years.

It is interesting to note that the average daily consumption dropped almost immediately upon the installation of meters on the industrial services last March. While we must not confuse the reduction in the water consumption of these industrials, which occurred with the general business depression of the past summer, with the reduction due to metering, there is no doubt concerning the effectiveness of the latter measure. The average daily consumption since industrial metering was instituted has been 14.7 million gallons as compared with 17.7 million gallons in 1923, 17.4

million gallons in 1922, 15.6 million gallons in 1921, 16.8 million gallons in 1920, and 16 million gallons in 1919, covering exactly the same period of time.

INTAKE WORKS

The intake will consist of a concrete pier located in the Ohio River 150 feet from shore, in approximately 15 feet of water at normal pool level, there being provided five openings for furnishing water for the low service pumps under varying conditions of river stage. In the river channel side of the pier is located a 36-inch cast iron pipe line extending into the river 381 feet from the center of the pier and continuing as a suction line from the extreme end out in the river to the low service pumps, with a valved opening on the interior of the intake pier serving as the normal suction opening. That portion of the pipe line extending out into the river will act as an extreme low water intake and water may be drawn through it by simply closing the gate valve on the 36-inch branch on the interior of the pier. The river end of the pipe is closed off with a wood bulkhead. When low water conditions develop the need for this emergency intake, in the case where the two next lower dams go down, the bulkhead may be removed by hand.

The intake pipe, acting as a suction line, passes through the low bank of the river towards the low service pumping station until the high bank is reached, where a concrete tunnel carries the pipe through the high bank and under the railroad tracks, into the low service pump pit. The tunnel is provided with space for two 36-inch intake lines with a concrete manhole on the river end, sufficiently large to permit of entry of 12-foot lengths of 36-inch cast iron pipe, should it be necessary to repair or renew the new line, or to construct an additional one.

PUMPING STATION

The pumping station is a fireproof building, housing three low service pumps, one of 10 million, one of 15 million and one of 20 million gallons daily capacity, located in a circular pit 40 feet in diameter and 60 feet deep; and three high service pumps of the same capacities located on the main floor at the top of the pit. All pumps are motor driven centrifugals, equipped with automatic motor starting devices, with push buttons located at both pumps and

switchboard. Current for the operation of pump motors will be furnished by the Wheeling Electric Company at 2300 volts, 3 phase, 60 cycles, with power available from three separate power circuits and two power plants. The low service pit has been provided with space for an additional pump. Two vacuum pumps are installed on the main floor for priming the centrifugal pumps. The low service pumps discharge through a 42 x 30-inch line into the grit chamber and settling basins. A 30-inch venturi meter is installed in this line just outside the building. The 42-inch line continues as such to the outside of the building where it reduces to a 30-inch line with provision for another 30-inch paralleling line when its installation becomes necessary. The low service pit is provided with both stairway and elevator. The high service pumps take their suction from the clearwell in the basement of the coagulant house through a 42-inch suction pipe and discharge through dual 31-inch steel lines leading to the City, so interconnected at the pumps that any pump may discharge into either of the lines. Check valves and gate valves are provided on the discharge lines and only gate valves on the suction lines of both low service and high service pumps. All gate valves for the pumps are hydraulically operated and controlled from operating stands located at the pumps.

The switchboard is located on the main floor on the west side of the building, while the automatic control panels and accessory electrical apparatus are located in an isolated room in the basement of the high service pump room just below the switchboard. In a room off the electrical control room are located the transformers for the lighting and power systems of all buildings.

A synchronous condenser has been installed to correct the power factor to unity to take advantage of the power schedule regarding this point. A machine shop is provided on the main floor and is part of the pump station building. A store room and an office for the chief engineer are provided on the second floor above the machine shop. In the basement of the machine shop are located the meter testing room and a toilet room with water closet, wash bowls and shower baths.

The adoption of electric power for all pumping purposes in a waterworks located in the heart of the coal region and with an expected annual power consumption of over 10 million k.w.h. is a distinct innovation. It was made possible primarily by the necessity for the construction of a new pumping station and filtration plant

with the abandonment of the present steam pumping station which brought into consideration the reduction in labor operating costs and in fixed charges which can be made with an electrically operated plant as compared with a steam plant, with the result that the electric plant was able to reduce in this comparison the extra cost of electric power over coal to the point where power was a matter of choice only. Current will be furnished by the Wheeling Electric Company on a special municipal tariff. Continuity of service will be practically assured by the installation of two power lines leading into the pumping station, connecting with three major transmission lines carrying power from the Beech Bottom Power Plant, which has a capacity of 180,000 k.w.h. and the Wheeling Electric Co. plant at Wheeling having a capacity of 10,000 k.w.h.

FILTRATION PLANT

Settling basins

The settling basins consist of a grit chamber, a mixing chamber, and two coagulating basins, having a capacity of 415,000 gallons or thirty minutes, 830,000 gallons or sixty minutes, and 3,330,000 gallons or four hours for both coagulating basins respectively. Normally, the water will discharge into the grit chamber through seven vertical 16-inch risers, extending 2 feet 2½ inches above the flow line to provide aeration. The water will then flow through the grit chamber without any artificial impediments and pass through a collecting wall consisting of a multitude of 4-inch holes, into the mixing chamber. The chemicals will be applied to the raw water in the mixing chamber at any point that treatment will require. Chemicals and raw water will be agitated by passing over and under vertical wood baffling designed to produce a velocity of 0.6 foot per second and capable of adjustment to whatever other velocity may be found most efficient. The concrete supporting and dividing walls are provided with vertical slots 20 inches center to center, to permit of this adjustment. Adjustable swinging gates are hung at the botton of all under pass baffles to permit of further regulation of velocities at these points. By means of by-pass gates, the period of mixing can be shortened to twenty minutes or even ten minutes as may be desired. The coagulated water passes from the mixing chambers into concrete flumes which discharge into either or both of the coagulating basins and so regulated by means of valves as to permit of either

series or multiple operation of these basins. A by-pass flume is also installed to permit of by-passing the mixing chamber, while the raw water discharge line is designed to permit of discharge into the mixing chamber direct, thus by-passing the grit chamber. The raw water line connects to a flume which permits also of complete by-passing of both grit chamber and mixing chamber, so that the raw water may be discharged directly into either or both of the coagulating basins. The coagulating basins are provided with multiple port walls on the influent end and with concrete weir walls and wooden overflow baffles on the effluent end. Both coagulating basins are provided with 18-inch overflow pipes.

All basins, including the grit chamber, mixing chamber, and the coagulating basins are provided with hydraulically controlled plug valves for draining purposes, with the control panels located in the mixing chamber building. The mixing chamber is covered by a suitable brick building to permit of more comfortable winter operation of this element of the plant. All concrete bottom floors are sloped not less than 5 per cent for draining. Four-inch pressure lines are installed within the basins, with suitably located hose connections for cleaning purposes. All basins are underlaid with cast iron drain pipes which have a minimum grade of 1 per cent, discharging into a 24-inch sewer leading to the river.

Chemical lines in the mixing chamber will consist of flexible rubber hose so supported as to permit of adjustment of point of chemical discharge. The alum or iron line furthermore extends to the coagulating basins where secondary application may be made to the settled water from one coagulating basin before it passes to the other in series operation. This chemical line is rubber hose supported on channel irons and provided with control valves at the desired points. The chemical lines enter the mixing chamber building through a 16-inch cast iron pipe conduit connecting with the coagulant house. This conduit also carries the steam heating pipe for the mixing chamber building. Another point of application for lime and iron or alum has been provided in the raw water discharge line at the venturi meter to be used whenever it is found necessary to by-pass the grit chamber and mixing chamber or if found economical under certain conditions as a preliminary treatment.

Filters

There are ten filters, each having a rated capacity of two million gallons per day. Each filter is divided into two parts by a concrete

sewer gutter which extends through the filter at right angles to the operating floor. Steel wash troughs spaced 7 feet 1½ inches centers extend through each half of the filter, parallel to the operating floor and discharge into the concrete gutter. The filtering media consist of 18-inch of gravel graded from 2½ inches to ⅛-inch and 30 inches of sand on top of this, having an effective size between 0.35 and 0.40 mm. and a uniformity coefficient of about 1.40. The gravel rests on a concrete false bottom 8 inches thick, in which are located bronze strainer pipes on 6 inches centers both ways. Slotted brass strainers are screwed into these strainer pipes. The water chamber under the false bottom is 20 to 21 inches deep, extending under the entire area of each filter including the sewer or influent gutter and serving as an equalizing chamber for the uniform distribution and collection of wash water and filtered water respectively.

There are two clear wells, one under each row of filters, so arranged that either one may be closed off and cleaned. Each clear well is connected to the pump suction well in the basement of the head-house by means of a 42-inch cast iron by-pass connection, provided with hydraulically controlled gate valves. The capacity of each clear well will be 220,000 gallons which together with the capacity of the suction well, namely, 53,000 gallons, makes a total of 493,000 gallons at maximum level or slightly more than 35 minutes storage when filtering at the rate of 20,000,000 gallons per day. The filter plant and pumping station are equipped with high and low water clear well alarms. The high service pumps will take their suction from the suction well through a 42-inch cast iron pipe.

All filters are provided with hydraulically controlled gate valves with marble operating tables located on the operating floor. A master control is installed in the lobby of the coagulant house, whereby the rate of flow through all filters may be regulated by hand from a central point. The rate controllers are equipped with automatic devices for regulating the flow from the filters in direct proportion to the water level in the clear wells. The filter operating tables are equipped with indicating loss of head and rate of flow gauges. The master control table is equipped with sample pumps for raw water, coagulated water, and filtered water, the latter taken from the suction well in the coagulant house; indicating clear well, rate of flow and wash tank level gauges; and a fountain tank in the center, together with the master control levers.

Wash water will be furnished from a steel tower tank located on the river side of the railroad tracks just west of the coagulant house. It has a capacity of 125,000 gallons which is sufficient to wash two filters. The tank will be sufficiently high to provide 15 pounds pressure at the filters when washing at the rate of 15 gallons per square foot per minute. Two 1000 g.p.m. pumps, automatically controlled, located in the basement of the coagulant house will serve to fill the tank. A venturi meter controller is installed in the 24-inch wash line in the coagulant house basement to control, measure and record the wash water flow to the filters. This feature is more or less new in water works practice.

Coagulant house

The coagulant house consists of a one story structure extending over the lobby and the easterly side of the building, with a four story tower on the west side in which are contained the chemical conveying, feeding and controlling equipment. On the first floor are located the chemical and bacteriological laboratories, storeroom and preparation room for laboratories; the lobby, superintendent's office, clerk's office, record filing room, chlorine room, and locker and toilet rooms. On the second floor are located the dry feed machines. The third floor, or strictly speaking, the chemical operating platform, is used for the manipulation of the storage bin gates and the charging of the daily chemical hoppers. On the fourth, or top floor, are located the elevator machinery and dust arrester. In the basement are the pump suction well, the clear well by-passes, the wash pumps, the heating plant for all buildings, the elevator and conveying machinery, and the coal storage room.

The chemicals will be delivered in bulk or otherwise on the new water works siding alongside of the coagulant house, where it will be unloaded into the vertical conveyor by means of a power shovel, and finally deposited through a system of conveyors into the various storage bins on the fourth floor of the building. A hammer crusher is provided at the foot of the bucket conveyor for pulverizing the lump lime and crushing the iron and alum if necessary.

There are five concrete storage bins, each having a maximum capacity, based on stored iron, of 85 tons, equipped at the lower end with hand operated gates for discharging the tank material into the daily hoppers to which are connected the dry feed machines, one for

each of the five storage tanks and daily hoppers. The dry feed machines are hand regulated, and water motor operated, each with a maximum daily capacity of 16,000 pounds of quick lime or 20,000 pounds of iron or alum, and capable of regulation of quantities between 0.1 and 5.7 grains per gallon of lime and 0.5 and 7.1 grains per gallon of iron or alum. Two machines are provided for feeding alum or iron, two for quick lime, and one for any of the three chemicals, the latter machine serving as a spare. The flow line in the solution boxes of the dry feed machines will be approximately 5 feet 6 inches above the raw water aerating pipes in the grit chamber.

A singular innovation in the chemical treatment plant is the use of pulverized quick lime rather than hydrated lime with direct feeding chemical machines, which are equipped with continuous slacking boxes provided at the outlet of the dry feed machine, and to which the chemical lines connect.

Cold water only will be used for slaking and solution water, as our observations at other plants have convinced us that there is no material economy in using hot water for this purpose when a special hot water system must be installed for the purpose.

Two manual control liquid chlorine machines of the "Pedestal" type are installed in the chlorine room and arranged to feed liquid chlorine into the pump suction clear well and into the 30-inch raw water pipe just outside the filter building. A Toledo platform scale is installed for weighing the chlorine.

An electric freight elevator has been provided for the coagulant house, reaching from the basement to the top floor. A dust arrester is installed on the top floor in the coagulant house to catch the dust during the unloading of the chemicals and throughout the building, wherever chemicals are handled.

Reservoirs

Five one million gallon steel reservoir tanks are being installed at the head of Jonathan's Ravine, at elevation 905, which is 5 feet higher than the existing reservoir. This was the only suitable site available. Steel tanks were determined upon, not only from the standpoint of economy, but from a structural standpoint also, in that the topography of the land would not permit of an extensive development of any kind of masonry reservoir without incurring a tremendous investment. Furthermore, the character of the soil

gave promise of slides which might crack and ultimately ruin a masonry reservoir, whereas a steel structure will take up considerable torsional strains and still retain its integrity even with a fair amount of settlement. The tanks should have a life of at least thirty years if properly maintained. A 31-inch steel equalizing pipe connects the reservoirs with the existing 30-inch cast iron force main at Coal Street. A double acting 24-inch altitude valve has been installed in the 31-inch steel line to regulate the height of water in the tanks and to prevent their draining in case of pipe line failure. A telemeter of the pressure diaphragm type is installed with transmitting equipment at the reservoirs and water level recording apparatus in the new pumping station. Each of the tanks is 75 feet 6 inches inside diameter by 30 feet high and provided with a 16-inch inlet-outlet pipe 8-inch drain pipe, and 8-inch overflow pipe.

OLD RESERVOIR

A float operated telemeter is being installed at the old reservoir to record water levels at the new pumping station.

FORCE MAINS

Two 31-inch steel force mains have been installed, each approximately 9000 feet long, connecting the new pumping station with the existing force mains at the present pumping station. Steel pipe was determined upon for two reasons: namely, economy and structural advantage. In the first place, the steel force mains, installed, are costing 25 per cent less than cast iron mains: and in the second place, due to the character of the ground in which the pipe lines are laid, slippage in case of cast iron might develop serious breaks and interruptions: whereas, with steel pipe such breaks or interruptions would not be so likely to occur. The force mains are cross-connected very completely at the existing pumping station and at the new pumping station, so that either line may be isolated if necessary. The force mains are equipped with air valves for elimination of air and also to prevent vacuum when draining.

REINFORCEMENT OF CITY AND PRIVATE WATER PLANTS

At the present time the old reservoir is used as a settling basin, since raw water is pumped into it first and then distributed. After the improvements are completed, it is the intention to operate both

old and new reservoirs as reserve capacity, that is, the pumps will discharge into the distribution system and the overflow will go to the reservoirs. To accomplish this, and furthermore, better to tie in the force mains with the distribution system, three 30-inch cross-connections have been installed at opportune points between the pumping station and the old reservoir.

UNIFICATION OF WATER SYSTEMS

Unification of the City water system with the four systems acquired by purchase was accomplished without great difficulty but at some cost. Under unified operation, all parts of the City will be supplied from the new pumping station, filtration plant and old and new reservoirs, thus reducing very materially the cost of operating the several plants as at present. The largest one of the private plants maintains, through necessity, two separate supplies one at each end of the system to restore lost friction head and to serve as an additional supply. These two plants are five miles apart with a single 8-inch main extending most of this distance and supplying the territory in between. By the installation of almost 4 miles of 16-inch main and over 1 mile of 12-inch main it will be possible to supply the furthermost of this territory from the new and old Wheeling reservoirs even though they are 100 feet lower than the highest reservoir of the private plants. The 16-inch main connects with the 31-inch rising main at the new reservoir tanks and passes through a concrete lined tunnel 261 feet long piercing the ridge separating the new reservoir from the Out-the-Pike District to be served by this main. It is expected to construct a booster station to supply a handful of consumers situated too high for the new conditions and also to furnish water for prospective new development at the higher levels.

Approximately 20,600 feet of 31-inch steel force and rising mains, 19,400 feet of 16-inch cast iron mains, 5600 feet of 12-inch, 6000 feet of 10-inch, and 10,000 feet of 8 and 6-inch mains besides three major cross-connections of 30-inch mains, were necessary to complete the unification of the water works system and to connect the present system with the new pumping station and filtration plant.

NEGOTIATIONS AND PURCHASE OF PRIVATE WATER PLANTS

The negotiation for and purchase of the private water utilities supplying the suburbs were conducted by the consulting engineers

in conjunction with the City Manager. Three of the plants were completely appraised and the purchases made at the engineers' appraised value. The appraisals were developed on the basis of fair value and worth to the City which eliminated from consideration the four pumping plants and sources of supply and three of the four reservoirs owned by these utilities. The City unquestionably was in a most advantageous position to negotiate inasmuch as the Statutes of West Virginia prohibited the granting of exclusive franchises thus permitting paralleling of the utilities' mains in competition. The fourth private water works was practically donated to the City in lieu of its assuming immediately the responsibilities of supplying the consumers, to which the City agreed. Three of the plants were contracted for at a total cost of $278,993 and the fourth at something more than $200.

COST OF IMPROVEMENTS

Contracts for the complete improvements have been let amongst fourteen contractors at a total cost of $1,666,903, divided as follows:

Railroad siding	$3,000
Intake works (pier, line and tunnel)	84,350
Pumping station, machine shop, etc.	283,558
Reservoirs	138,370
Filtration plant	567,000
Force mains, extensions, cross-connections, etc.	590,625
Total	$1,666,903

ORGANIZATION

To create confidence in the general public, the City Manager selected five representative citizens of the City of Wheeling, of which two are women, to act with the entire City Council and the City Manager as a Pure Water Commission having control of the expenditures made in connection with these improvements. The five citizen members have equal voting power with the City Council in deliberation, although they have no standing officially. C. H. Dowler was City Manager when the improvements were begun while J. S. Butts is City Manager at the present time. F. S. Stow was Resident Engineer with five assistant engineers or inspectors and a stenographer making up his field organization. The writer supervised the improvements from the Pittsburgh office of the J. N. Chester

Engineers, Consulting Engineers. J. W. Shull is the newly appointed superintendent of the Water Works and G. E. Rickard, Chemist in Charge of the Filtration Plant. H. A. Conrad is City Engineer. The John F. Casey Company, Pittsburgh, is general contractor on substructures, Engstrom and Company on superstructures, Pittsburgh DesMoines Steel Company on pipe lines and reservoirs, Worthington Pump & Machinery Corporation on pumping machinery and M. L. Bayard & Company on filter equipment, besides nine others on equipment, materials, etc.

HISTORICAL SKETCH OF WHEELING WATER WORKS[1]

By J. W. Shull[2]

One of the earliest developments of the City of Wheeling was the establishment of a water works system in 1834. The first record of this sytem is to be found in a Council Ordinance of October 15, 1834. This created a Council Committee together with a superintendent and engineer, who were to control and operate the water works. In this way the affairs of the department were managed until the creation of a water board in 1882.

The first plant consisted of an upright engine with a capacity of approximately 1,000,000 gallons per day. This plant was situated on the east bank of the Ohio River at 8th Street. The reservoir was located on Alley "C," between Seventh and Eighth Streets, and had an impounding capacity of approximately 750,000 gallons.. The distribution mains were run through the principal streets of the town. This plant served its purpose until the year of 1830 when the growth of the community demanded an increased capacity.

A contract was entered into with the firm of Helm & Richardson Company on July 5th of that year, by which that firm agreed to erect a pump with a 10-foot stroke by 12-inch diameter plungers, together with a side lever engine of 20 inches in diameter by 7-foot stroke, with the necessary steam boilers and other accessories to operate this machinery. The price agreed upon was $8900, and the work was to be completed in six months, so that the new pumping equipment was placed in operation the early part of the year 1840. The daily capacity of this pumping equipment was approximately 1,500,000 gallons.

In the year 1855 a contract was made with the firm of J. Moore & Company by which the first pumping equipment was replaced with an engine and pumping machinery of approximately the same character and capacity, making the total pumping capacity of 3,000,000 gallons daily. This machinery furnished an ample supply during

[1] Presented before the Central States Section meeting, December 5, 1924.

[2] Water Department, Wheeling, W. Va.

the year 1881, when it became altogether inadequate to supply the growing demands of the city.

A Worthington horizontal, high pressure duplex pump of approximately 3,000,000 gallons capacity was then added to the plant. This necessitated the building of a new boiler house in which were installed two batteries of four boilers each to furnish the necessary steam power. During all this time the works had been managed and controlled by the Councilmanic Committee on Water Works as originally constituted. While the revenues had been ample to make all necessary extensions and improvements, they had been diverted to other purposes, as a result of which there were numerous breakdowns of the pumping equipment, notably in 1881, just before the Worthington pump was completed and put to work, when the greater part of the city was almost entirely without water for weeks. This created public agitation for a better system for controlling the works and its finances, that the revenue derived from this department might be used for its betterment and extensions.

The outcome was that an act was passed by the Legislature of the State on February 27, 1882, by which the City Water Board was created. It consisted of three members, one of whom was to be its president. These were to select a superintendent and such other officers and employes as was to be necessary. The Board was to have control of the entire system under rules and regulations approved by Council and was to select and disburse the revenues that accrued from same. The first Board elected under this Act was composed of William Hastings, John G. Hoffman, Sr., and John Oesterling. It met and organized on May 16, 1882. William Hastings was elected temporary secretary and prepared an ordinance adopting the rules and regulations for the government of the Board which was passed by Council on July 13, 1882. On July 14, 1882, Alexander Updegrass was appointed by the Board as Secretary and as John Oesterling died on November 27, 1883, on December 6 of the same year Lott H. Joy was elected to fill the vacancy. The superintendent at this time was James H. Riddle.

The control and supervision of the water system has remained in the hands of successive boards elected from time to time until May, 1909, when the new charter went into effect and the system went under the management of the Board of Control. One of the first acts passed by the Board of Control was to install new pumping equipment owing to increased demands on consumption caused by

the installation of many hydraulic elevators by the business houses and increased capacity of manufacturing plants plus large increases in wastage and in unnecessary leakage due to the lack of necessary inspection.

In 1886 there was completed and placed in operation a compound condensing unit of 4,000,000 gallons daily capacity built by the Gordon-Maxwell Company, of Hamilton, Ohio, making a total pumping capacity at this date of approximately 10,000,000 daily. In 1888 the construction of the present reservoir near the head of Seventh Street on Wheeling Hill was started and completed and placed in use in 1894. In the meantime, as there had been considerable agitation as to removing the pumping plant outside of the city limits and above the sewerage system, the Board secured the services of Messrs. Dunham and Paine, a firm of hydraulic and consulting engineers, who made a thorough examination of the system and reported that it was entirely inadequate to supply the wants of the city and was so situated as to take in all of the sewage of the north end of the city, making it dangerous to the health of the people. There was, besides, only one pumping unit that could furnish water to the new reservoir and it was essential to keep this unit in service continuously in order to maintain water at the higher level. They recommended, therefore, the placing of a new station at a point approximately 2½ miles above the city and submitted an estimate of $320,000, which included a main to the new reservoir.

The Board submitted this report to Council in August, 1891, and asked that body to give them authority to build the plant. The Board stated that, if they were allowed the use of its entire revenue for a term of 6 years and were relieved of paying interest on city bonds, it could make arrangements to have the work done on long term payments and could pay for it out of the revenue of the department without requiring any additional sum from the city. Council granted this request, and on November 12, 1891, a contract was made with the Holly Manufacturing Company of Lockport, N. Y., to build two modern high duty, vertical, compound condensing pumping units, 7,500,000 gallons daily capacity each. A subsequent contract was made with the same firm to furnish and lay a 30-inch discharge main from the new plant to the reservoir. Contracts were also let for the construction of the necessary wells and buildings to house the machinery and equipment, and electric light plant and other necessities for the operation, all of which were completed and

put in operation on November 30, 1893. There was added to this and put in operation, in 1902, an additional high duty, vertical compound condensing pumping unit of 12,000,000 gallons daily capacity, built by the same firm. This necessitated additional buildings and well for the housing of this equipment.

In 1904 and 1905 an additional force main of 30 inches in diameter was laid from the new works to the hill top reservoir. The capacity of the pumping station at this time was 27,000,000 gallons, while the boiler room contained 1800 H. P. in Heine water tube boilers.

About 1909 a contract was entered into with the Allis-Chalmers Machinery Company for the 20,000,000 gallon vertical triple high duty condensing pumping unit, which has served our needs to the present day. This improvement cost approximately $320,000, and has operated almost continuously for the past 11 years. The total cost up to our 1922 bond issue was approximately $1,250,000 in pump equipment, lines, reservoirs, etc.

At the present time, before the new improvements go into effect, the City has in use the pumping station just described, the reservoir mentioned above, with a capacity of 3,600,000 gallons, 20 miles of 4-inch pipe, 16 miles of 6-inch, 6 miles of 8-inch, 1½miles of 10-inch, 2¼ miles of 12-inch, 1½ miles of 14-inch, 1¾ miles of 16-inch, ½ mile of 18-inch, 3½ miles of 20-inch, 1¾ miles of 30-inch.

TREATING RAILWAY WATER SUPPLIES IN IOWA[1]

By C. R. Knowles[2]

Our railway systems, traversing various sections of the country, meet with numerous and interesting varieties of water which must be made use of in locomotives.

Many of these waters are unsatisfactory for use in their natural state and it is one of the problems of the railway water service engineer to develop satisfactory supplies or treat the objectionable waters in such a manner that they will be suitable for boiler use.

The principal boiler water problems involve scale formation, corrosion and foaming, and while they are all serious and worthy of investigation and treatment for their control in any boiler, they are particularly troublesome in locomotives, and it is perhaps for this reason that the railroads have been, to a certain extent at least, the leaders in boiler water treatment.

While there is no complete record of the total number of water treating plants in railroad service throughout the country, a fairly accurate estimate indicates that there are in the neighborhood of 900 complete treating plants using the lime and soda ash method of treatment, over 10 per cent of them being located within the State of Iowa.

The large number of water treating plants recently constructed by railroads is an indication that the value of good water for locomotives is receiving more consideration each year, and a survey of the activities along this line indicates that the construction of water softening plants in Iowa equals, if it does not exceed, that of any other portion of the country having a similar railroad mileage.

Although the question of good water has always been an important factor in locomotive operation and maintenance, interest in the treatment of railroad supplies has undoubtedly been stimulated during the past few years by the greatly increased cost of fuel and boiler repairs and the added importance of keeping locomotives in service.

[1] Presented before the Iowa Section meeting, November 6, 1924.

[2] Superintendent, Water Service, Illinois Central R. R., Chicago, Ill.

Nearly all waters used by railroads in Iowa are highly mineralized or to use a common expression they are "hard waters." The State of Iowa is deeply covered by drift and soil composed chiefly of finely divided material which contains considerable amounts of calcium sulphate and other more soluble compounds. The rainfall comes in contact with this material and that portion of the rainfall which becomes ground water must pass through it, giving the water opportunity to take up mineral matter. Only small superficial sand areas in the State take up the rainfall and transmit it as soft water to wells or streams. The deep rich soil also contributes indirectly to the mineralization of water, as nearly the whole area is covered with vegetation of some sort, and the soil contains large amounts of decaying vegetable matter. An unusual amount of carbon dioxide is thus supplied to the water at the surface which enables it to dissolve large amounts of calcium and magnesium carbonates.

Iowa rivers contain very much greater amounts of mineral matter in solution than the rivers of the whole continent. The average total solids of the Des Moines, Cedar and Iowa Rivers as determined by analyses of the United States Geological Survey are 16 grains per gallon while the average of the river waters of the continent is 9 grains per gallon. The total solids for the Iowa rivers as given above include only the dissolved mineral matter; if the suspended matter is included the total matter carried by the river waters is more than 32 grains per gallon.

The same general agreement is found between the mineral content of the waters of the rivers and that of the best deep wells. A wide variation is found in the well waters, the best wells containing about 15 grains total solids while the worst waters contain 60 grains or more. Apparently an increase in the mineral content of the waters is found from the northeast to the southwest corner of the state.

It is not the intention to leave the impression that the waters of Iowa are the worst in the country, but they are of such a nature that with few exceptions they can be improved for boiler use by treatment.

The railroads of Iowa used these waters in their natural state for many years and while boiler troubles due to bad water conditions were expensive and annoying they were looked upon prior to twenty years ago as a necessary evil, and efforts towards improving water conditions consisted chiefly of the application of soda ash and various compounds.

It should not be inferred from this statement that the question of water supply was not given the proper consideration at that time, for, as previously stated, interior treatment was used extensively. This period of locomotive boiler water treatment has been referred to as the "era of soda ash" as most of the roads were then using soda ash or similar material applied direct to the tanks of engines. Trisodium phosphate, petroleum mixtures and various other schemes of treatment within the locomotive boilers were tried out with varying results.

With the advent of heavier locomotives carrying higher steam pressures, increased tonnage and faster train schedules the question of improved water supply became more important, and was in fact an economic necessity, for the complete treatment of boiler waters in Iowa was probably most forcibly brought to the attention of the railroads in the early part of 1900 as the record of one Iowa railroad would indicate that train movement was seriously interrupted during the winter of 1901 and 1902 on account of bad water, the most serious condition being the leaking of locomotive boilers. During the month of January, 1902, 109 engine failures were reported on the Iowa lines of this road, 91 of which were due to leaky flues. These failures affected 145 trains from one to four hours each. It was apparent that the condition of the engines was growing rapidly worse, as during the first ten days in February 1902, 56 engine failures occurred, nearly all of which were due to leaking flues. It was nothing unusual to have engines out of the shop for less than ten days fail completely. Instances were cited where engines with only 600 or 700 tons would have to reduce tonnage on account of leaking flues. In one month alone it was necessary to reduce trains 13,604 tons in addition to which 478 hours time was lost.

Soda ash was used extensively in an attempt to relieve conditions and while it stopped most of the leaking its increased use caused so much trouble from foaming that the operation of the locomotives was almost as difficult as with the former leaking condition.

Another railroad operating in Iowa reports that during the eight months from August, 1902, to and including June, 1903, a total of 583 engine failures occurred on their Iowa Lines, 352 miles in length, all of these failures being due to leaking locomotives. Upon the completion of water softening plants on this line the reduction in engine failures the first year the plants were in operation amounted to 79.4 per cent notwithstanding the fact that there was an increase of 7.5 per cent in ton miles during this period.

These conditions undoubtedly hastened the construction of complete water softening plants, and I am glad to say that the complete treatment of water on the lines in question has improved water conditions to such an extent that an engine failure is not almost unknown.

The Chicago and Northwestern Railroad was the pioneer in the construction of complete water treating plants in Iowa. Their first plant was erected at West Side early in 1903. They also built a plant the same year at Council Bluffs, Iowa; the Illinois Central followed with the construction of treating plants at Dyersville, Manchester and Peosta in 1904. Other roads followed closely on the heels of the Northwestern and Illinois Central in the construction of water softening plants, until at the present time there are a total of eighty-four known plants on six of the principal railroads of Iowa. There are a number of plants on other roads not included in this list that will bring the total up to 100 or more.

According to the Interstate Commerce Commission reports of 1922 there are 9837 miles of railroad in Iowa, and as railway water stations are located an average distance of 20 miles apart there are between 450 and 475 water stations in the state, about 100 or 22 per cent of which include complete lime and soda ash treating plants.

The following tabulation shows the number of treating plants in service on six of the principal railways systems in Iowa, together with the quantity of water treated annually, percentage of total consumption of water treated and date first plant was constructed:

	NUMBER OF PLANTS	GALLONS WATER TREATED	PER CENT OF WATER TREATED	YEAR FIRST PLANT CONSTRUCTED
C. B. & Q. RR.	22	1,269,000,000	78	1912
I. C. R. R.	22	1,031,600,000	90	1904
C. & N. W. R. R.	20	986,000,000	43	1903
C. R. I. & Pac. R. R.	14	926,567,000	40	1908
C. M. & St. P. R. R.	4	127,750,000		1905
C. G. W. R. R.	2	156,000,000	14	1906
Totals	84	4,496,917,000		

The above figures take into consideration only that proportion of water used which is given complete treatment by the lime and soda process. There is very little water used by the railroads in Iowa that is not now treated to a certain extent, for where complete

FIG. 1. IOWA FALLS, IOWA, WATER TREATING PLANT

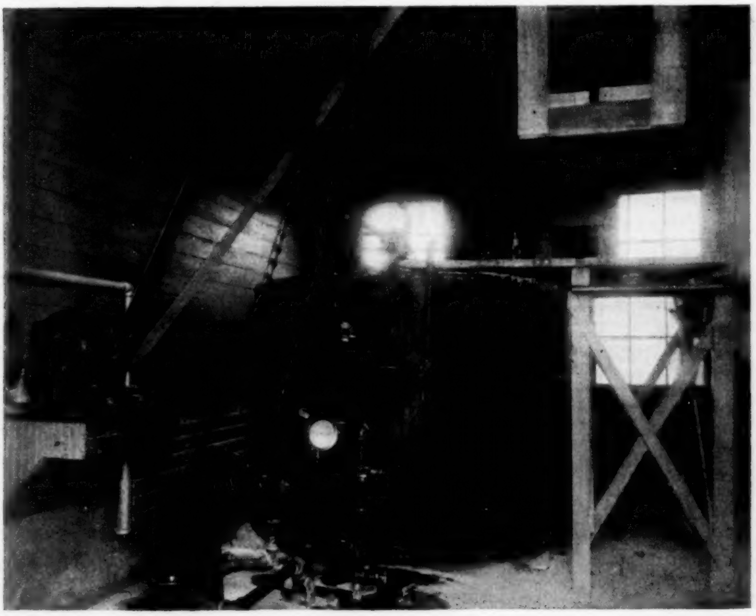


FIG. 2. INTERIOR FORT DODGE, IOWA, WATER TREATING PLANT

treating plants are not provided boiler compound and soda ash are used in its stead. Over 90 per cent of all the waters used by railroads in Iowa is treated in some manner.

For example, while only 90 per cent of the water used on the Illinois Central in Iowa is given complete treatment, the remainder of the water is treated by means of compounds, compounds being applied direct to roadside tanks from Sioux Falls, South Dakota, to Ft. Dodge, Iowa (not including Cherokee where we have a complete treating plant) and by compounds applied direct to engine tank from Cherokee to Onawa and from Manchester to Cedar Rapids.

Water treatment as followed by railroads may be roughly divided into two general methods, namely, interior and exterior treatment, the first covering the use of chemicals and boiler compounds introduced directly into the boiler, the second covering treatment and removal of the scale forming material before the water enters the boiler. Where facilities are not provided for fully treating the water outside the boiler the use of a good compound or even soda ash alone is sometimes advisable and is followed by fairly good results when properly applied. There is no doubt, however, that almost without exception a properly designed treating plant offers the most satisfactory and economical method of treating Iowa waters for locomotive use. Past experience has proved that the use of compounds or soda ash should be limited to such points where the consumption of water is small and where the expense of maintaining and operating a complete water softening plant cannot be justified.

Complete water softeners as used for treating locomotive boiler supplies are built in two general types, intermittent and continuous systems. In the intermittent treating plants two or more tanks are always required as it is necessary to allow the water to stand after treatment until reaction and precipitation has taken place. In the continuous treating plant one tank may be used as the process of reaction and precipitation takes place as the water is passed through the softener.

While nearly all railroad water softening plants follow the same general principles of construction they vary widely in the method of applying chemicals, method and time of agitation and design of tanks.

The latest design of continuous water treating plant used by the Illinois Central, twelve of which have recently been erected in Iowa, differs somewhat from the general design of railway water treating

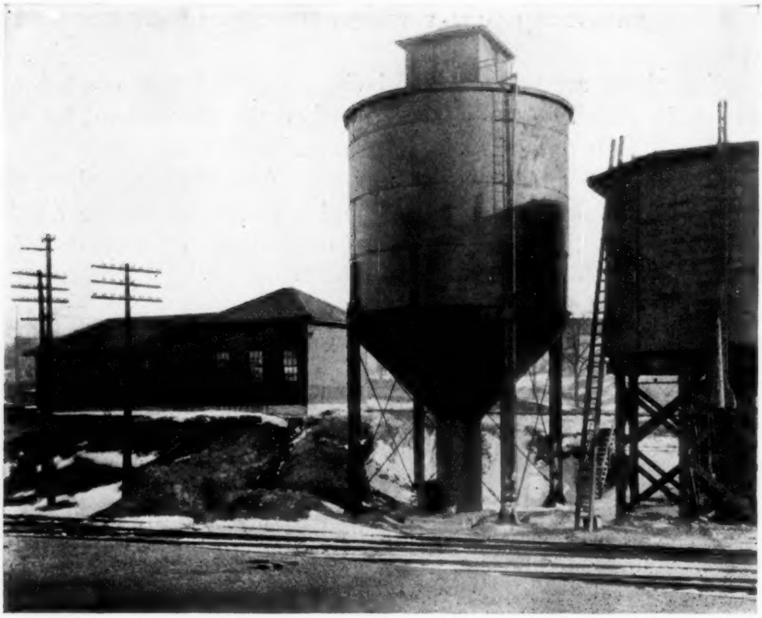


FIG. 3. FORT DODGE, IOWA, WATER TREATING PLANT

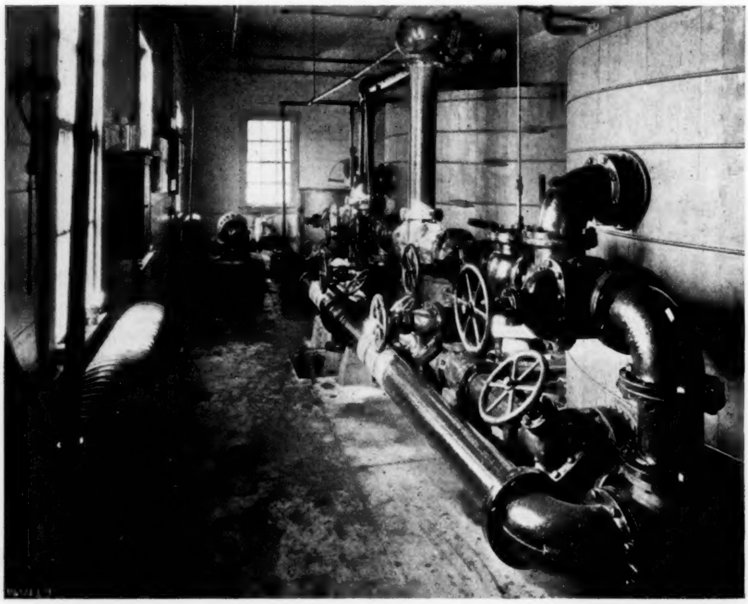


FIG. 4. INTERIOR IOWA FALLS, IOWA, WATER TREATING PLANT

plants. The outstanding features of the Illinois Central plants are the conical bottom tanks and sand filters. The conical bottom tank is a radical departure from the commonly accepted practice of building flat bottom steel tanks of the standpipe type or elevated wood tanks of similar design. The advantage of the conical bottom tank is principally in the economy of sludge removal, only about 10 per cent of the water used in sludging the flat bottom tank being required to remove the sludge in a conical bottom tank. The conical bottom tank also has advantages over the flat bottom tank for water softening in a number of other respects.

The filters used in connection with the water treating plants on the Illinois Central lines in Iowa are of three types, excelsior or wood fiber being installed in two of the gravity plants, while twelve of the plants are equipped with pressure sand filters and eight with gravity sand filters. Sufficient head is provided above the roadside tanks to overcome the resistance of the filter beds where pressure filters are used and the water flows by gravity from the softener to the storage tank, while the rehandling plants have clear wells or basins into which the water flows from the open sand filters and is repumped to the storage tank.

As an example of the advantages of using treated water in locomotives the Illinois Central Railroad constructed and turned over to operation the latter part of January 1922, seven water treating plants on the Iowa Division. The quality of the untreated water ranged from 16 grains incrusting solids per gallon to 42 grains with an average of 24 grains. These treating plants were located on one engine district which is a policy we follow in the construction of treating plants, as this practice prevents the mixing of treated and untreated water in the same locomotive. In estimating the saving through the operation of these treating plants we followed the method recommended by the American Railway Engineering Association in 1914, which was based upon actual engine tests conducted in 1912, at which time it was determined that each pound of incrusting solids removed from boiler water was equivalent to a saving of 7 cents in the cost of repairs and fuel. Adjustment of charges for fuel and boiler repairs to date brings this figure up to 13 cents, and using the figure of 13 cents per pound for solids removed and deducting cost of interest, depreciation, operation and maintenance we estimated a net saving of $46,326 per annum on an investment of $135,000. However, comparing the expense for operating and maintaining locomo-

tives during the period 1922 and 1923 with 1920 and 1921 (which was prior to the construction of the water softening plants on this district) we found that the estimated saving was too low, the actual reduction in the cost of operation and maintenance of locomotives due to improved water conditions on this district being equivalent to more than 100 per cent earning on the total investment. This is only one of a number of instances that might be cited as showing the saving through treatment of locomotive boiler water as the value of water treatment has been thoroughly demonstrated by other railroads having water softening plants in service, not only in the State of Iowa, but throughout the country.

A speaker presented figures before the Western Society of Engineers, Chicago, January 22, 1923, showing that the use of an average bad water in locomotives caused an expense over the use of a good water of more than $4000 per locomotive per year. Experience in the treatment of Iowa waters has proved this figure to be approximately correct.

In closing let me call particular attention to a factor that must always be given attention in the improvement of locomotive boiler supply and that is the matter of organization and supervision.

The best and most expensive apparatus will not produce the desired results unless correctly and continuously operated. Good results can be secured only by careful and systematic supervision. This is accomplished on the Illinois Central by traveling chemists who check the treatment on the ground and instruct the treating plant attendants as to the proper quantity of chemicals to use and in the general operation of the plant.

By following this system we have removed the element of uncertainty and have established our treating plants as important factors in the successful operation of locomotives in bad water territory.

SEWAGE DISPOSAL AND WATER PURIFICATION IN THE UPPER OHIO RIVER BASIN[1]

By Philip Burgess[2]

In view of the fact that this meeting is being held at Wheeling at a point overlooking the Ohio River and that the cleaning up of this river today presents one of the most interesting sanitary problems now confronting the engineering profession, the speaker will confine his remarks to the tremendous sanitary problem which now presents itself in the upper Ohio River valley, particularly in regard to the proper disposal of the enormous quantities of domestic and industrial wastes now discharged into the stream and to the possibility of obtaining satisfactory water supplies for the very large population now existing along the upper shores of the Ohio River.

In the following discussion the speaker will attempt to describe briefly, first the industrial development along the Ohio River and what important causes have contributed to this development and, second, what has been the development in the purification of the public water supplies, particularly with reference to the problems presented along the Ohio River in obtaining potable municipal water supplies. He will also attempt to show whether or not the problems of securing satisfactory water supplies have been solved, and what steps, if any, must be taken in the future in order to secure more satisfactory results.

DEVELOPMENT OF THE OHIO RIVER BASIN

The Ohio River has well been called a "Course of Empire." For many years it was the important western avenue of expansion for the American continent. The river is formed by the junction of the Allegheny and Monongehala Rivers at Pittsburgh and the early trails from the eastern seaboard crossed the Allegheny Mountains and extended to the Ohio River basin at Pittsburgh and

[1] Presented before the Central States Section meeting, December 6, 1924.
[2] Consulting Engineer, Columbus, Ohio.

Wheeling. The course of migration was westward by way of these trails, thence by embarkation on the Ohio River by canoes, flat boats, or steam boats, and by debarkation at sites along the river down stream, which have since become of importance such as Cincinnati, Ohio, and Louisville, Kentucky. Until the construction of the railroads, in 1860, the steam boats on the Ohio River offered the best means of transportation throughout the Ohio River valley. With the construction of the large trunk railways, transportation by steam boat has been of less importance, but the river always will offer an important avenue for transportation of large shipments of raw and manufactured products. During the present century, the importance of the river as a means of transportation has been recognized by the Federal government which has developed a program of constructing a 9-foot waterway, or channel, to be available for navigation throughout the entire year except when the river may be closed by ice. A large part of this program has already been completed and has been and will be of great importance in developing the Ohio River valley.

The Ohio River drains the largest tonnage producing district on the American continent and probably on any continent. The raw and manufactured products carried into and out of the upper Ohio River valley already run up into hundreds of millions of tons yearly and is expanding rapidly from year to year. The manufacture of steel and iron products in this district surpasses that of any other district in the world. This has been made possible in part through the cheap transportation provided on the river and in part by the abundant water supply also provided by the Ohio River. The use of the river as a source of water supply for industrial purposes far surpasses the use of the river for domestic purposes and has been a most important factor in the wonderful development of the Ohio River valley.

Just as it has been the general custom in this district to obtain all public and industrial water supplies from the Ohio River, so it has been the universal practice to dispose of all sanitary and industrial wastes by direct discharge into the river without any attempt at purification, except that provided by dilution aided by the natural processes of oxidation and self purification of the stream. It is necessary to present only a few data to indicate what a tremendous burden of domestic and industrial wastes is being disposed of in this manner.

STREAM FLOW AND POPULATION TRIBUTARY

Unfortunately there are not any very extensive data available to determine the low stream flows of the Ohio River. Investigations of the stream flow were made by the United States Geological Survey, 1906, particularly at Wheeling, West Virginia. The drainage area of the Ohio River above Wheeling is 23,800 square miles and the minimum flow found in September, 1906, was 6400 cubic feet per second, or 0.27 second foot per square mile. The total area of the watershed of the Ohio River above the Indiana-Ohio state line is 80,947 square miles. It is probably not unreasonable to estimate the minimum flow from the entire water-shed at not over 1600 cubic feet per second, based upon a flow of about 0.2 second foot per square mile.

The total population on the water shed in 1924 has been estimated from the United States Census Reports for 1900, 1910, and 1920 at approximately 8,800,000 and is increasing at the rate of approximately 2 per cent yearly.

On the basis of the total population of 8,800,000 tributary to the stream and a minimum flow of 1600 cubic feet per second, the minimum flow per 1000 population is only about 18 cubic feet per second for the entire watershed. Experience indicates that the minimum permissible dilution with respect to a marked nuisance from odors is generally found at from 2 to 5 second feet per 1000 population. In view of the fact that the concentration of population of the district at and below Pittsburgh is very much greater than the average throughout the entire watershed and in view of the tremendous use of the river water for the disposal of industrial wastes, many of which effect a marked reduction in the oxygen available in the stream, it is obvious that the flow of the Ohio River is not always sufficient to provide a proper dilution of the sanitary and industrial wastes entering the stream. Furthermore we should expect to find by actual analyses that the river is unfit for use as a public water supply without adequate purification. This fact is supported by actual analytical data. It is not necessary to resort to field data and to local inspection to learn that along the upper reaches of the river there are many places where local nuisances prevail and where the river is grossly polluted by sanitary and industrial wastes.

THE DEVELOPMENT OF WATER PURIFICATION ALONG THE UPPER OHIO RIVER BASIN

In view of the remarkable development and concentration of population and industries which has taken place along the Ohio River particularly from its source at Pittsburgh to the Ohio-Indiana State Line, it is of interest to note what has been the corresponding development in obtaining satisfactory water supplies particularly for the urban population residing along the shores of the river. In this connection, it should be noted that practically the entire population depends upon the Ohio River for its public water supply. While it is true that a very few small communities obtain their supplies from the ground water sources, in general the ground water available throughout the upper Ohio River valley is limited in quantity, is very hard and is high in mineral content so that it is not satisfactory as a public supply. It is only natural that the communities along the Ohio River should turn to this stream as the source of their public water supplies. The Ohio River valley has contributed much to the advancement of the art of water purification. Three extensive and instructive set of experiments on water purification have been conducted at Louisville, in 1898, and at Cincinnati and Pittsburgh in 1899. These experimental plants were constructed with a view to determine the best method of purifying Ohio River water. As a result of these experiments, large water purification plants of the so-called "rapid sand" type were constructed at Louisville and Cincinnati, and of the "slow sand" type at Pittsburgh.

In 1909, the firm of which the writer was then a member was employed by The Ohio River Sanitary Commission of Ohio to investigate the uses of the Ohio River both as a source of public water supply and for the disposal of sanitary and industrial wastes. A striking fact brought out in this investigation was that, as late as 1909, a large percentage of the population on the Ohio River used river water as the source of its public water supply and that only one-half of the entire population on the river was supplied with water purified by filtration processes. Although this investigation covered only the uses of the Ohio River in Ohio, West Virginia, and Kentucky along the Ohio State Line, its results are representative and significant. It was true at that time as it is today that none of the municipalities, or industrial plants, had provided means for

the proper purification of the sanitary and industrial wastes which were discharged directly into the stream. This investigation showed also that the raw Ohio River water was polluted at all points above the Ohio-Indiana State Line and in its raw state was entirely unfit for domestic use. Today the only cities still using unpurified Ohio River water as the source of their supplies are found in Kentucky in the district across the river from Cincinnati.

RESULTS ACCOMPLISHED BY THE WATER PURIFICATION PLANTS TREATING OHIO RIVER WATER

From the foregoing discussion it will be observed that throughout its entire course from Pittsburgh to the Ohio-Indiana State Line, the Ohio River water is badly polluted by domestic and industrial wastes now discharged into the stream without any attempt at purification except by dilution in the river: that a large percentage of the population residing along the river are dependent upon this stream for their public water supplies: that, in most instances, the public water supplies obtained from the Ohio River are now purified by filtration processes. It is next of importance to consider what results are accomplished by these filtration processes. Do the water purification plants along the Ohio River valley always furnish satisfactory public water supplies?

Before answering this question it is important to consider that, in the Ohio River valley, plants are to be found representing the highest type of water purification plants yet developed. Furthermore the usual filtration processes are supplemented by sterilization with chlorine at practically all of them. The purification plants are in charge of skilled chemists and bacteriologists, men who are specialists in their line and who are able to get the best results from the plants operated under their supervision.

Notwithstanding these facts, it is of great interest to note that not a single plant in the Ohio River valley produces at all times an effluent which will pass the Federal standard of purity. The reason for this is obvious. Each step of the usual purification, or filtration, processes removes only a percentage of the number of bacteria contained in the water before treatment. This percentage of bacterial removal may be very high, but the important consideration is not the number removed, but the number of bacteria remaining in the treated water. It is obvious, therefore, that, if the raw water is

grossly polluted, the number of bacteria remaining in the treated water may be excessive. Such at times is the condition now prevailing along the Ohio River. The burdens, or loads, at times placed upon the water purification plants are excessive and if we are to obtain continually satisfactory water from the Ohio River we must either improve the water purification processes or improve the quality of the raw water treated by the plants.

The speaker believes that there can be only one answer to this question, namely, we must improve the quality of the raw water by cleaning up the Ohio River. In this short discussion it is not necessary to consider how this cleaning up shall be accomplished. It is sufficient to say that it must be accomplished. The problem of obtaining satisfactory water supplies along the upper Ohio River has become one of sewage disposal, or sewage treatment, as well as one of water purification. Just as the upper Ohio River basin is the most important district on this continent from an economical and commercial standpoint so will the problem of cleaning up the Ohio River soon be recognized—if it is not already so recognized—as one of the most important sanitary problems in the country. The satisfactory solution of this problem will require a large understanding of the proper relation between the principles of sewage treatment, of the disposal of industrial wastes and of the purification of public water supplies. To date the entire burden of obtaining satisfactory water supplies has been placed upon the water purification plants. If we are to consider the health and happiness of the residents of the upper Ohio River basin, we must from now on take into consideration the limitations of the available water purification processes and we must provide a more proper disposition of the enormous quantities of sanitary and industrial wastes which the Ohio River alone is now called upon to remove.

SEMI-DIESEL ENGINES FOR WATER WORKS[1]

By J. B. Trenchard[2]

It occurs to me that you will be more interested in the adaptability or practicability of the modern oil engine for pumping water than you would be in a technical discussion of a Semi-Diesel engine, (the subject assigned me). Therefore, I will touch briefly only upon what constitutes the design, construction and operation of an internal combustion engine, but devote most of the time allotted me to point out some of the advantages being realized by the development of the internal combustion engine.

When I speak of an internal combustion engine I refer to a machine from which energy is obtained by harnessing the force of an explosion, whether from kerosene, gasoline, fuel oil, or gas, and it may be done by using low compression electric ignited engines, or Semi-Diesel engines, or the full Diesel type.

The Semi-Diesel is an engine in which the fuel is ignited by compression with a small portion of the heat contained from the previous combustion. In this type it is necessary to equip the engines with a torch for starting. The full Diesel is a type wherein the compression is high enough to ignite the fuel even though the engine is cold.

The internal combustion engine today is the result of many years of experimenting, which dates back to about 1775, the first experiment being with gunpowder. It was about 1900 when the development was perfected to a point wherein the engine was beginning to be recognized as a dependable and economical power apparatus. Since about 1900 the development has been so rapid that few people realize the remarkable contribution it has made to the welfare of all mankind.

Perhaps an illustration comparing the engine with an automatic rifle will enable you to see clearly the principle on which the internal combustion engine operates. The cylinder of the engine represents

[1] Presented before the Iowa Section meeting, November 8, 1924.

[2] Fairbanks Morse Co., Des Moines, Ia.

the barrel of a gun, the fuel represents the powder, the piston represents the bullet and the electric spark represents the cap. As the piston is shot out of the cylinder, it is the power stroke, it can only go the length of the stroke regulated by the crank shaft, as it is connected to the crank shaft by what is known as the connecting rod, and when it has reached the extreme end of the stroke it is returned to the upper end of the cylinder, the required amount of fuel being admitted in the meantime, so it is re-shot, over and over again. As stated above, some engines are ignited by an electric spark, the Semi-Diesel engines by compression and some of the heat contained from the previous combustion and the full Diesel from compression only.

In other words, an internal combustion engine is just as few pieces of iron put together in such a way that, when gasoline or fuel oil is applied, they become what might be termed in one sense alive, they move of their own accord, and produce energy for driving any other machines requiring power. This is accomplished merely by taking advantage of one of Nature's laws.

The following are a few of the industries that the internal combustion engine has made possible: automobiles, auto trucks, fire trucks, small city electric lighting and water plants, farm electric light and water plants, aeroplanes, submarines, motor boats, irrigating systems, drainage systems, dredges for ditching purposes, inspecting and railway motor cars, battleships operated on land, better known as tanks, and for many other power purposes which time will not permit me to mention.

What would have been the condition of the times during the past 24 years had it not been for these industries? Would we not still be back in the times of the 90's? As I see it, as soon as the internal combustion engine was developed to a point where it was recognized as a dependable machine, it opened up directly and indirectly many new channels requiring a vast amount of additional raw material and labor, over and above what the world had been called upon to furnish before.

In addition to the internal combustion engines being the key to the industries which have required this vast amount of additional raw material and labor, they have given us two things we are all striving for, namely, speed and economy. They have enabled man to swim under water like a fish, by use of the submarine; to fly through the air like a bird, by the aeroplane, and to travel over the

highways at a speed equal to a railroad train, by the automobile, and through the automobile they have shortened the distance between our places of business and our homes and places of recreation.

Before the invention of the steam engine, or the development of the oil engine, the only means of transportation was by team. When our forefathers started west by team if they averaged twenty miles a day they were making good time. At that rate it would have required 300 days to make the trip from New York to San Francisco and back. In November 1919 Mr. Maynard made the trip from New York to San Francisco and return in 9 days and 4 hours, in a machine propelled by an internal combustion engine. Since that time the trip has been made from New York to San Francisco within 24 hours.

Now we get down to the points in which I think you will be more interested, that is, the economy and dependability realized by the latest improved internal combustion engines for power plants, the full Diesel type. In order that you may appreciate their economy I first would like to make a comparison with a 100 h.p. Corliss steam engine, operating non-condensing under full load for a period of ten hours, which is the type in use in most of the smaller municipal plants. The steam engine will require approximately 6 pounds of coal per h.p. hour, consequently the steam engine will require 600 pounds of coal per hour, or 6000 pounds in ten hours, or 3 tons, which at $5.00 per ton would be $15.00.

A 100 h.p. Diesel Oil engine operating under the same load and for the same time will not use in excess of 65 gallons of fuel oil; the present price of fuel oil delivered to most points in Iowa will average approximately 5 cents per gallon; therefore, in operating the 100 h.p. Diesel Oil engine the fuel oil cost will not exceed $3.25 as compared with the steam engine at $15.00.

Figure 1 shows the cost compared with electric current, electric current being available at 1½ cents per kilowatt. This comparison is made on the basis of using a 50 h.p. electric motor, and a 50 h.p. oil engine. The 50 h.p. oil engine with 5 cents fuel oil can be operated at full load at a cost of 19 cents per hour; with 6 cents fuel oil at 22 cents per hour; the electric motor being operated at full load with current available at 1½ cents per kilowatt would cost 56 cents per hour, or approximately three times the cost of operating the oil engine.

The Diesel Oil engine, when operating a power pump having an

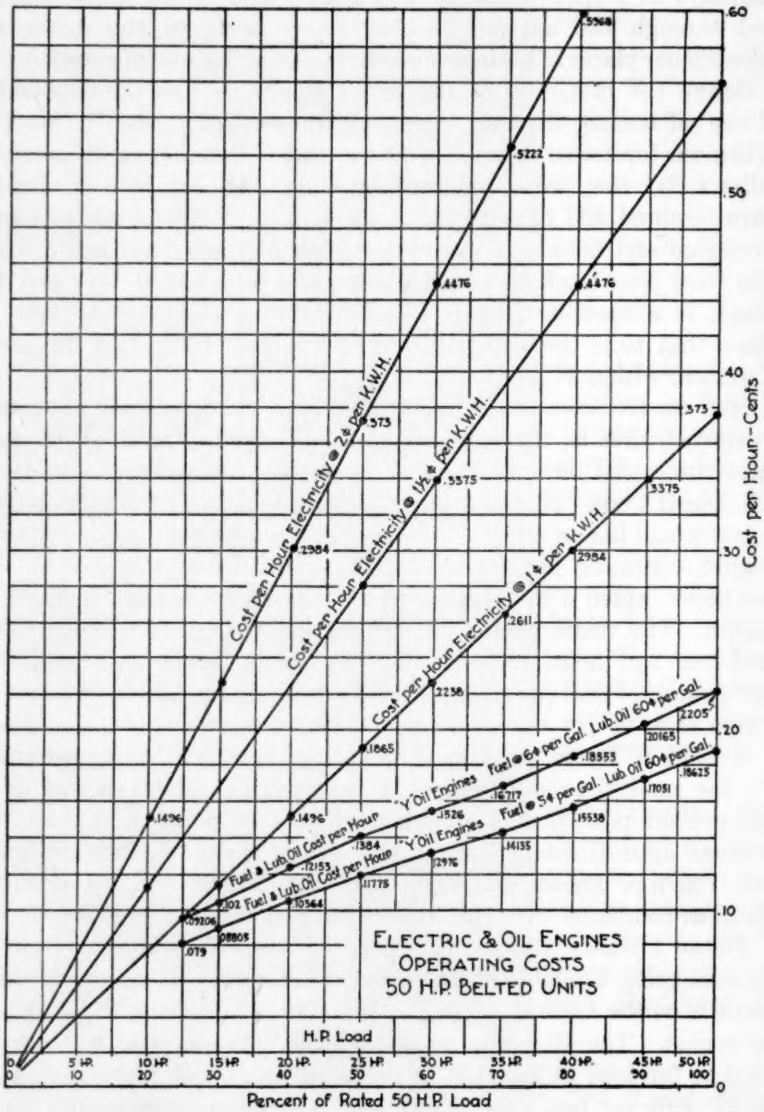

Electric & Oil Engines
Operating Costs
50 H.P. Belted Units
Cost per Hour Electricity @ 2¢ per K.W.H.
Cost per Hour Electricity @ 1½¢ per K.W.H.
Cost per Hour Electricity @ 1¢ per K.W.H.
Fuel & Lub. Oil Cost per Hour "Y" Oil Engines Fuel @ 6¢ per Gal. Lub. Oil 60¢ per Gal.
Fuel & Lub. Oil Cost per Hour "Y" Oil Engines Fuel @ 5¢ per Gal. Lub. Oil 60¢ per Gal.
Cost per Hour-Cents
H.P. Load
Percent of Rated 50 H.P. Load

Fig. 1

efficiency of 75 per cent and with fuel oil available at 5 cents per gallon will pump 1000 gallons of water against a 500-foot head at a fuel cost of 1 cent per 1000 gallons; or 1000 gallons of water against a 375-foot head, at a fuel cost of $\frac{3}{4}$ cent or against a 250-foot head at a fuel cost of $\frac{1}{2}$ cent per 1000 gallons, or against a 125-foot head at $\frac{1}{4}$ cent per 1000 gallons. In fact this computation could be used in figuring any quantity of water against any head.

As evidence of what is being accomplished or being realized by municipalities who have investigated, purchased and installed oil engines for pumping their water supply, I desire to submit a report taken from the records setting forth the conditions existing at Perry, Iowa.

The City of Perry has 4 deep wells which are equipped with deep well pumps operated by electric motors, which pump the water from the deep wells into a surface reservoir, located at the plant. Prior to installing an oil engine equipment last spring, they were using a large fly wheel type steam pump, pumping the water from the surface reservoir into the distribution system, against direct pressure.

Prior to making the installation of oil engines and generators last January, they were purchasing electric current from a utility company for operating the motors on the deep wells and a sewage lift pump located in the plant.

For a twelve month period previous to making the installation of the new equipment their fuel cost for operating the steam-drive pump, and their electric current for operating the deep well and sewer pumps were as follows:

Electric current at $2\frac{1}{4}$ cents per kilowatt	$5,859.20
Coal and wood	6,653.02
Total	$11,512.22

During that period they pumped 213,214,000 gallons of water. Therefore, their cost for electric current, coal and wood was 5.39 cents per 1000 gallons.

After completing the installation of the new equipment and instituting a system of accurate records, during six months their cost and results have been as follows:

MONTH	GENERATED	FUEL OIL USED AT 5½ CENTS PER GALLON	WATER PUMPED
	kilowatt hours		*gallons*
April	31,071	3,181	18,460,000
May	35,030	3,555	18,050,000
June	36,610	3,686	19,054,000
July	37,770	3,963	18,917,000
August	38,920	4,017	18,958,000
September	39,880	4,175	19,706,000
	219,281	22,577	113,145,000

The above records show that they are generating 9.71 kilowatt hour per gallon of fuel oil consumed and at the present price would be equivalent to 0.54 cents per kilowatt hour and is also equivalent to a cost of 1 cent per 1000 gallons, which will net a saving of something over $825.00.

During the period of the six months referred to above they pumped 113,145,000 gallons of water at a fuel cost of 1 cent per 1000 gallons and when compared with their former cost of 5.39 cents per 1000 gallons with their former equipment, it shows a saving of 4.39 cents per 1000 gallons times 113,145,000 gallons for six months, a saving of $4,967.06, or, per year, approximately $9,934.12.

At this rate the savings in three years will amount to considerably more than the cost of the equipment.

Their new plant consists of two 100 h.p. type "Y" fuel oil engines, direct connected to dynamos and three centrifugal pumps direct connected to electric motors. The three centrifugal pumps take the place of their former large fly wheel type steam pump, pumping from the reservoir into the distribution system and have a variation in capacity of from 400 to 1200 gallons per minute, the engines and generators furnishing electric current for operating the deep well pumps, the centrifugal pumps, and the sewage pump and all lights that are used in their building.

Every pumping job is an individual engineering proposition, as rarely, if ever, are two problems exactly alike. In order to realize the highest degree of efficiency it is advisable to direct connect the motive power with the pump. This eliminates any loss between the two.

Many cases are similar to the one at Perry, Iowa, where they have several deep wells from which the water is pumped into a surface

reservoir and from the surface reservoir into the distribution system, against what is termed direct pressure. In such cases as this it requires several pumps, not only for the deep wells, but boosters on the distribution system, in order to furnish the required amount of water for regular consumption and an adequate amount at the time of a fire. It is advisable to put in direct connected motors and centrifugal pumps and by specifying oil engines direct connected to generators, when operating at capacity, current can be furnished at a cost equivalent to 1 cent per kilowatt hour.

MEASUREMENT OF PIPE FLOW BY THE COÖRDINATE METHOD[1]

By F. W. Greve[2] and Maurice J. Zucrow[3]

MEASUREMENT OF PIPE FLOW BY THE COÖRDINATE METHOD

The determination of the discharge capacity of an open pipe from measurements taken of the coördinates of the upper surface curve of the jet is by no means new. However, in view of the scanty data available on this subject, the authors feel justified in presenting the results of some experiments recently performed at Purdue University. These experiments covered the discharge from 3, 4, 5 and 6 inch pipe when partly filled.

The purpose of the tests was to determine the relation between the discharge, q, from a horizontal pipe open to the air, and the distance, y, from the top inside of the pipe to the surface of the jet (see fig. 1).

The apparatus used and the set-up are shown diagrammatically in figure 2. The apparatus was designed to insure that the ordinate, y, would be measured in the plane $z - z$, and to the center of the top surface of the stream of water as indicated in figure 1. The discharge was measured in a weighing tank during tests which varied from three to eighteen minutes, according to the rate of flow. The number of tests on a pipe ranged from 42 to 84.

The recorded data, consisting of the distance y for a particular rate of flow and the corresponding rate of discharge, are noted in table 4. The ordinate y was read in 64ths of an inch, and the discharge in a given time was measured in pounds.

Let y = ordinate of jet (in inches).
d = diameter of pipe in inches; the nominal diameter can be used with sufficient accuracy for practical use.
$k = (d - y)/d$ = ratio of depth to diameter.
q = discharge in cubic feet per minute.

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[1] Presented before the Indiana Section meeting, January 22, 1924.

[2] Associate Professor of Hydraulic Engineering, Purdue University, La Fayette, Ind.

[3] Research Assistant, Engineering Experiment Station, Purdue University, La Fayette, Ind.

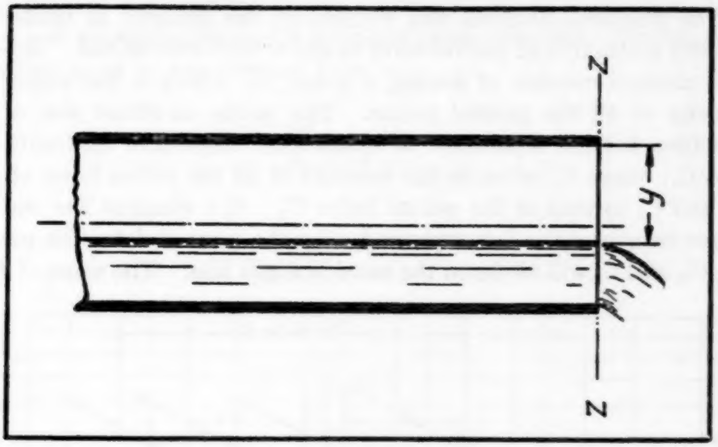

FIG. 1. SECTION ON AXIS OF PIPE

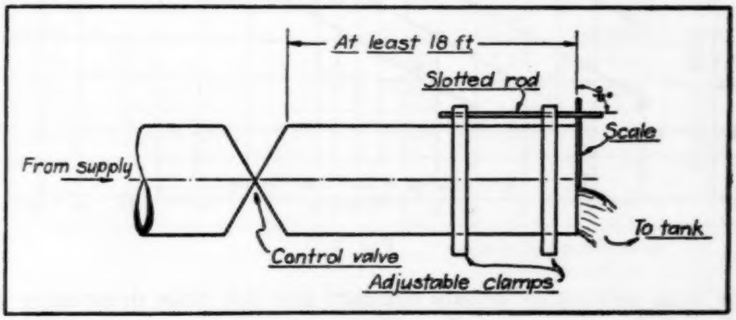

FIG. 2. SET-UP OF APPARATUS

The data obtained for each pipe were plotted on logarithmic cross-section paper; different values of the ratio k being plotted as ordinates against q as abscissas. For each pipe the resulting graph was a straight line, indicating that for any one pipe the following equation applied,

$$k = mq^n$$

or

$$\log k = \log m + n \log q$$

where m and n are constants for a given pipe.

The graphical analysis was verified by the centroid or center of gravity method; and the values of m and n were determined. Briefly this method consists of finding a point, C_2, which is the center of gravity of all the plotted points. The points on either side of C_2 are then treated separately to locate their respective centroids, C_1 and C_3; where C_1 refers to the centroid of all the points lying above C_2 and C_3 to that of the points below C_2. If a straight line on log paper expresses the law represented by the plotted data, the points C_1, C_2, and C_3 will all lie on the same straight line. The slope of this

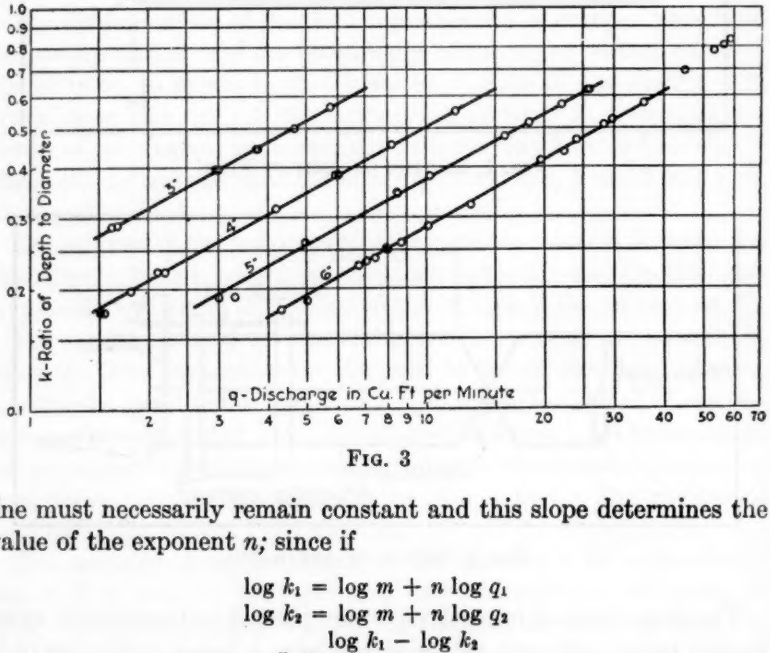

FIG. 3

line must necessarily remain constant and this slope determines the value of the exponent n; since if

$$\log k_1 = \log m + n \log q_1$$
$$\log k_2 = \log m + n \log q_2$$
$$n = \frac{\log k_1 - \log k_2}{\log q_1 - \log q_2}$$

That the graph of the data plotted on logarithmic coördinate paper is a straight line is demonstrated by table 1.

Since n varies only 7.6 per cent (see table 1), it can reasonably be assumed that the graphs representing the equation $k = mq^n$, for each of the pipes tested, are parallel to each other; the average value of n for these curves being $n = 2.192/4 = 0.548$. Using the average value $n = 0.548$, the discharge equation becomes

$$k = mq^{0.548}$$

This form of the equation is not convenient, since in the field, the ratio k is determinable and q is an unknown quantity. Hence, the equation must be transformed thus:

$$q = Bk^s$$

where
$$s = \frac{1}{n} = \frac{1}{0.548} = 1.82$$

and
$$B = \left(\frac{1}{m}\right)^{1.82}$$

then
$$q = B\ k^{1.82}$$

TABLE 1

Values of n for pipes tested

VALUE OF k BETWEEN CENTROIDS	NOMINAL DIAMETER OF PIPES IN INCHES			
	3	4	5	6
C_1 and C_2	0.528	0.551	0.545	0.568
C_3 and C_2	0.528	0.551	0.545	0.568
C_1 and C_3	0.528	0.551	0.545	0.569
Average n for each pipe	0.528	0.551	0.545	0.568

TABLE 2

	SIZE OF PIPE IN INCHES (d)			
	3	4	5	6
B	16.65	34.84	60.62	99.43
Log B	1.2214	1.5421	1.7826	1.9975
Log d	0.4771	0.6021	0.6990	0.7782

In table 2 are given the values of B for the different pipes tested, when $s = 1.82$. The values of B were then plotted on logarithmic cross-section paper as ordinates against d as abscissas. The resulting graph was practically a straight line, showing that the relation between B and d can be represented by the exponential equation

$$B = d^r$$

where
$$r = \frac{\log B}{\log d}$$

In table 3 are given the values of r for the different pipe sizes. The average value of r was taken as 2.56. Hence the complete equation for the flow from any of the pipes tested is,

$$q = d^{2.56} k^{1.82} \text{ cubic feet per minute}$$

TABLE 3

PIPE DIAMETER	r
inches	
3	2.56
4	2.56
5	2.55
6	2.57

TABLE 4

Summary of results

3-INCH PIPE		4-INCH PIPE		5-INCH PIPE		6-INCH PIPE	
k	q	k	q	k	q	k	q
0.212	0.971	0.175	1.55	0.620	26.1	0.176	3.47
0.213	0.971	0.175	1.50	0.620	25.8	0.321	13.1
0.288	1.67	0.220	2.10	0.569	22.1	0.436	22.5
0.287	1.61	0.220	2.21	0.515	18.2	0.521	29.5
0.396	2.93	0.382	5.91	0.474	15.8	0.468	24.0
0.396	2.97	0.382	6.01	0.380	10.2	0.570	35.7
0.443	3.79	0.453	8.25	0.378	10.1	0.271	6.66
0.444	3.73	0.451	8.23	0.191	3.29	0.187	5.02
0.565	5.74	0.547	11.9	0.190	3.00	0.177	4.33
0.567	5.74	0.543	11.9	0.263	4.97	0.251	8.01
0.500	4.67	0.315	4.19	0.259	4.97	0.508	28.1
0.499	4.66	0.315	4.20	0.345	8.51	0.416	19.6
0.194	0.843	0.198	1.79	0.343	8.55	0.285	10.2
0.197	0.851	0.198	1.82			0.260	8.72
		0.198	1.80			0.251	8.08
						0.237	7.45
						0.233	7.14
						0.228	6.79

This equation applies for values of k between 0.2 and 0.65 only, for when k is much less than 0.2, the stream does not spring clear and the law of flow is different. Also, above $k = 0.65$, the pipe is not partly filled for its entire length. On the contrary, the pipe is entirely filled with the exception of a small distance from the end. This con-

dition changes the hydraulic radius suddenly from $\frac{R}{d} = 0.2900$ approximately, to $\frac{R}{d} = 0.25$[4] and the law of flow is different. This effect is shown by the curving of the graph for values of k above 0.65 (see fig. 3).

That the part-full condition holds true for an ordinary pipe only up to $k = 0.65$ or thereabouts, was verified by some experiments that the authors conducted on the flow of water in glass tubes of 65 mm. diameter.

In closing, the authors wish to bring out the fact that, although their own experiments were performed recently, this method of determining flow from an open pipe has been assigned to senior students as a thesis subject at various times within the last five or six years. The student work in this case checked that of the authors within reasonable limits, leading to the conclusion that the equation suggested for the flow from partly-filled, horizontal pipes is substantially correct. It is the policy of the hydraulic section of the Purdue University Engineering Experiment Station to use student research work merely for guidance and as a check on work to be undertaken by members of the staff at a later date.

The authors are extending their research to pipes completely filled. They have performed a considerable portion of the work and hope to have the results ready for publication at an early date.

[4] See Hughes and Safford's Hydraulics, p. 457, Table LXV.

METER SHOP METHODS[1]

By A. P. Lovell[2]

The best account of practice in San Diego may be given by following the meter from the time we receive it from the manufacturer.

All meters as delivered to us are put on the test bench, tested and sealed. The meter shop foreman delivers the meters to a service foreman on request, checking each meter by make, size and number. When installed by the service crews this same information is given on service installation order and returned to shop clerk, who makes out a card for each meter and files it.

In due time, from wear, sand or some of the various causes with which we are all more or less familiar, the meter reader will find this meter dead or in his estimation not registering correctly. The meter reader carries a pad of blank forms on which he notes his findings and attaches this to the page of his meter book carrying the record of this meter. These books all go through the hands of the chief meter reader who removes trouble slips and transfers notes to what we term a meter change sheet.

This sheet shows the name and address of the property owner, tap number, number of meter readers field book, style, make and number of meter, together with last reading and date taken. This sheet is forwarded to the field repair crew who change the meter and return it to the meter shop with a card attached showing why the meter was removed and also all data on meter installed in its place. On the reverse side of this card is space for the meter shop foreman to report what repairs were necessary.

In the meter shop the meter is turned over to a laborer who cleans and prepares it for the repairman. It then goes to the repair bench where new gears, disks, or whatever may be necessary are renewed or repaired. When a repaired meter is returned from the test bench, it is tested and sealed and is again ready for service. All dials are set back to zero. Large meters, that is from 3-inch and up, are usually repaired in the field.

[1] Presented before the California Section meeting, October 24, 1924.

[2] General Foreman, San Diego Water Department, San Diego, Calif.

When disassembled we often find the meter has been damaged by hot water warping the disk. As we cannot force the property owner to install a check valve on account of the danger of an explosion, we repair the meter and charge property owner for all damage.

The City of San Diego has approximately 26,000 meters in service and these are all cared for by two field and two shopmen.

New services, 3-inch and larger, are now cared for by batteries of 2-inch meters and we are replacing existing large meters with batteries as rapidly as our funds will permit.

A check of the increase in revenue to the city derived from the battery installation over the large meter is interesting. I shall cite a few instances in which I have taken the revenue from certain services for a month of one year and for the same month of the succeeding year, the large meter being replaced with a battery in the meantime. Of course, we have no means of knowing whether consumption was approximately the same in both cases, but we take for granted it was nearly so.

3-inch meter, store and rooming house	September, 1920	$4.45
Battery	September, 1921	11.85
3-inch meter, store and rooming house	November, 1920	3.00 min.
Battery	November, 1921	6.30
4-inch meter, hotel	October, 1921	34.05
Battery	October, 1922	53.10
3-inch meter, hotel	June, 1923	15.90
Battery	June, 1924	32.40
4-inch meter old disk type	June, 1924	18.30
Battery	September, 1924	190.20

POLLUTION AND NATURAL PURIFICATION IN THE OHIO RIVER

A REVIEW

By RUSSELL SUTER[1]

Adequately to review the results of studies made by the Public Health Service on the self-purification of the Ohio river, the results of which have recently been published in Public Health Bulletin No. 143[2] would require vastly more time than the writer can devote to the task. In the following pages an attempt has been made to touch upon the principal facts brought out and to comment somewhat on the methods used and results found with certain suggestions for further study.

This bulletin contains some 350 pages of tabulations, diagrams and charts. Voluminous as it is, the original data are many times more bulky, as the published results are mostly monthly averages of daily observations. The fundamental data in it will prove a veritable mine of information with regard to stream pollution problems whenever the key that will unlock the puzzle has been worked out. No claim is made that the key is contained in the bulletin, instead it is stated with admirable frankness that further study will be required.

To produce this work required an enormous amount of labor, both in the field and in the office. Those who collaborated in it are to be congratulated upon the result. Various factors entering into the problem are clearly and well presented and the whole shows a properly laid foundation for future and more exact determination of the various phenomena under study.

It must be realized that this was pioneer work as far as the original

[1] Water Control Commission, Albany, N. Y.

[2] Treasury Department, United States Public Health Service, Public Health Bulletin No. 143, July, 1924. A Study of the Pollution and Natural Purification of the Ohio River. II. Report on Surveys and Laboratory Studies. Prepared by direction of the Surgeon General under the supervision of Surgeon W. H. Frost, Washington Government Printing Office, 1924.

planning went. The field work was done during 1910–1914, whereas the results from the Potomac were not available until 1916, so that these could not be applied to field problems. Both the published results of the Potomac investigations and some results of the study of the Illinois river now under way were available for working up the results on the Ohio and have been utilized.

In any problem as complicated as this the results which are to be obtained would, if known, largely influence the original field work. Only by carrying through such a study is it possible to discover what tests are needed, so that the work must progress by the method of trial and error. In this case the investigators planned with vision and did well, even though in the light of present knowledge other tests would doubtless have been made.

Geographic and hydrographic data need no discussion; they were essential to the other work, but were not new fields of study.

Chemical studies are to be gone into further in a later bulletin and may be dismissed except for this finding:

Total nitrogen tests were found to be more representative than those for oxygen consumed and paralleled the turbidity, indicating that the total nitrogen content was derived more from surface wash than from sewage. It seems possible that this clue may be found important in the evaluation of residual effects; in determining the sanitary quality that the stream would have if all sewage were eliminated from it.

Studies of bacterial counts resulting from sewage pollution and the rate of decrease of such counts under natural stream conditions may be said to be the principal subject treated. It was found that the number of B. coli per unit volume (colon index) was the most important indicator of sanitary conditions and in this review the findings with regard to bacterial counts on gelatine and on agar will be largely neglected.

Although the Ohio in the reaches studied was nowhere fit to use as a source of domestic water supply without filtration and could not be so used even though all sewage were excluded from it, it was not in general heavily polluted. All communities which used it as a source of supply with purification methods of accepted types enjoyed a reasonable typhoid death rate and there was no evidence that their purification plants were overloaded.

Marked differences in bacterial content were found between winter and summer conditions. These could not be accounted for by

seasonal differences in dilution or in decreased death rate due to low temperature. There seemed to be a definite change in the number of bacteria, such as was found by Phelps in streams on the Canadian boundary. Below Cincinnati the B. coli were almost ten times as numerous in October as in January. It is to be hoped that this effect will be run down to its source. These bacteria largely originate in the human digestive tract and incomplete tests, made by William Firth Wells, seem to indicate a seasonal variation there. This is a line of research which the Public Health Service is well equipped to carry out.

Perhaps the most surprising fact brought out is the relatively much less effect on the bacterial content of the stream produced by the sewage of Pittsburgh and Wheeling as compared with that of Cincinnati and Louisville. It is stated that this can in part be explained by the differing physical character of the water of the Ohio and its tributaries at these points and by differences in the trade wastes in the sewers, particularly those from the iron industries.

In most cases the bacterial content of the river appeared to increase for a short distance (a few hours) down stream from the large cities. This is explained as in part being due to errors in sampling, the breaking up of infected solid matter and clumps of bacteria. It is a phenomenon which has heretofore been noted, particularly with sterilized sewage—evidently it is important and needs further study.

By tests in the river it was found that each person tributary to a sewer in Cincinnati and Louisville contributed from 200 to 500 billions of B. coli per day. It is stated that these figures are higher than had previously been supposed. In spite of this statement it would seem that the actual daily per capita contribution to the sewer itself must be materially higher, as the tests were made when the sewage must have been several hours old and had been diluted. Here again it would seem that this question should be studied at its source. It is one of essential importance.

At the expense of tremendous statistical labor curves showing the variation of the colon count for the stretch between Cincinnati and Louisville were constructed. These were plotted with age as abscissae, starting from the point of highest count. They were worked out for summer and for winter conditions. These curves, as plotted on semi-logarithmic paper (log count expressed as per cent of original count per cubic centimetre as ordinates) can best be described thus:

For summer conditions the curve starts as a straight line with

a slope such as to reduce the original count to 10 per cent in 2 days, which slope continues up to 6 days; here it changes somewhat sharply to another straight line with a slope that would reduce any count to 10 per cent in 17 days; the maximum reduction given being to 0.03 per cent in 500 hours (21 days).

For winter conditions the two line effect is less marked, but it begins at the same slope as for summer. Fairly accurate results up to a reduction to 3 per cent at 150 hours are shown and the curve is extended approximately to a reduction to 1 per cent at 400 hours (16½ days).

An attempt is made to apply this curve to the determination of the curve which should be found in another stretch of river. This check is not over satisfactory and it is stated emphatically that the published curves cannot be held to show the fundamental law of decrease of B. coli with time.

To the writer these curves are most notable on account of the very high rate of reduction shown in the earlier periods. This is several times as high as the Potomac results suggest. In addition, the similarity of the upper parts of the winter and summer curves is worthy of careful study and is unexpected.

It is to be regretted that this bulletin does not include an attempt to derive the true colon death rate from these fundamental data. Such study can profitably be made only by the men intimately connected with the work. It is to be hoped that it will be made and the results will be awaited with eagerness.

We may well speculate as to what the true curves of death rate would be and in this way only is it possible to check the assumptions made in the derivation of the above curve and to see how the data in this bulletin can be used to secure the desired information.

It is obvious that the colon count found at any point of a stream is dependent on many variables—of which the sewage contributing population, volume and velocity of stream flow, colon death rate, temperature and surface wash (residual pollution) are perhaps the most important—and of these several are unknown. If two or more observations are to be compared it is obvious that all variables but one should be eliminated. In the work under consideration much of this elimination was attempted by assuming that certain variables were too small to effect the results. There is some reason to doubt the entire justification of these assumptions and to think that more valuable results could be found by neglecting nothing without proof

that it has no effect, by comparing results from which variables can certainly be eliminated and by using averages as little as possible. The course followed was the proper one as a first assumption, and would doubtless have been changed had the work been carried further.

If we had all the data we desire we should be able to compute the colon content of a stream at any point, or to plot the colon intensity profile. It is interesting to see what sort of curve would result.

Clearly such a curve would be different for each rate of discharge and change of temperature. By assuming some definite discharge, temperature and date, many variables are eliminated or are of known value and from the data we would have: sewage contributing population and per capita coli contribution, volume (dilution) and velocity (time of transit) of flow and distances between points in linear measure and in time. In order to construct a curve similar to those in the bulletin we must know the death rate of B. coli (fecal), number and death rate of B. coli (spore formers) and residual pollution.

For reasons which will afterwards appear, the B. coli death rate will start at a rate a trifle more rapid than shown on the curves and will continue at that rate for a longer time—perhaps indefinitely—certainly the death rate curve will lie to the left of the plotted curves, especially in the lower portions. Let such a curve be assumed.

A curve of stream flow can be constructed. This will be a line something like a flight of steps, rising to the right. There will be a sharp increase at each tributary and a small and perhaps uniform increase between tributaries.

A curve of actual sewage contributing population can also be constructed. This will be of the same general form as the discharge curve, but will step up at each sewered community as well as at each tributary.

This curve of actual population can be reduced to a curve of effective population by applying the B. coli death rate directly to the population figures and making due allowance for velocity of the current. The revised curve will lie below the original curve and instead of being a flight of steps will be a saw-toothed line, each tooth being more or less vertical on the upstream side and sloping or curving downwards in the downstream direction.

By dividing the effective population at each point by the dis-

charge at the same point a curve can be constructed showing the colon count at each point. This curve will have the characteristics of the effective population curve, in that it will be a jagged line, going up sharply at each community and changing up or down at each tributary.

Correction must then be made for coli from boats, which will, for a stream navigable for its whole length, be more or less regular, perhaps showing a general increase either up or downstream and tending to some concentration in cities. The effect of this correction will be to raise the whole curve first plotted and with semi-logarithmic plotting this raising will be much more apparent in the lower than in the higher portions of the curve.

Correction must then be made for spore formers of the B. coli type. These are supposed to be of non-fecal origin and the curve may differ most essentially from that of the fecal coli. In the Potomac it was nearly uniform and in the lower reaches the numbers of spore formers were over twice those of all the fecal B. coli. It was unavoidable, but not the less regrettable, that differentiation between these two forms was not made in the Ohio river studies. If the Potomac results are even approximately applicable to the Ohio, the tendency of this correction would also be generally to raise the curve, particularly in the lower portion.

Correction must then be made for the fecal B. coli introduced by surface wash—the coli that would be present if all sewage were pumped off the watershed. We have at present the most scanty knowledge of this matter, but we know and it is stated in the bulletin that this effect alone would be to make the stream an unsafe source of water supply. It seems fair to assume that whatever the magnitude of the ordinates of the curve, the general shape would be much more regular than that of the curve of sewage coli, so that the correction would have somewhat the same general effect as those above noted.

If now we change the abscissae of the curve from distance to time, re-compute the ordinates as percentages of the value at the points used in the bulletin, select points on the curve corresponding to the sampling stations and draw a smooth curve through them, we should get the curve of the bulletin. It will be seen that then we would have two curves of entirely different characteristics, from either of which the colon count at any point could be read with nearly equal accuracy, but whereas the jagged constructed curve

would betray its origin in every angle, vertex and slope, the smooth curve would completely mask the fundamental laws on which it depends.

From the above it seems that the effect of neglected factors is nearly always to make the colon count profile higher and more curved than the death rate curve. Any downstream discharge of sewage lifts the lower portion of the curve bodily and these lifts, even though small individually, may have considerable affect in the aggregate. Other bacteriological phenomena tend also to raise the curve and particularly the lower part of it. The only phenomena having opposite effect are the additions of the waters of tributaries cleaner than the main stream and the discharge of some waste or different water which would have a bactericidal or coagulating effect. For this reason it was stated that the true death rate curve probably lay to the left of the curve in the bulletin and was probably much steeper in the lower portions. In other words, if the published curve were corrected by taking out the various neglected factors, it would at each step be thrown to the left towards a position slightly back of the initial line prolonged. Mathematicians might advise passing at once to the limit as the true expression of the law of decrease. Nothing at present known justifies this, but it should at least be considered.

In the text it is stated that the published curve appeared, as plotted on semi-logarithmic paper, to be composed of two straight lines (a condition also shown in the Potomac results). The question then arises as to whether these lines should be combined to form one curve or whether they represent the effects of independent phenomena. The steeper line certainly represents the death rate pretty nearly. The flatter line is of much the form that would result from spore formers, pollution from boats and surface wash—whether it represents them in magnitude cannot be stated. In any event it seems to the writer that study of conditions with this idea in view might give valuable results.

Consideration of the "hitched" form of the theoretical curves shows that considerable errors may result from averaging counts at equal time intervals, but with varying flows. Velocity of current and hence time varies with the discharge, while points of lower pollution or changed dilution are fixed geographically. This matter is too self-evident to need further comment.

When this work was planned the present differentiation of the B.

coli into two distinct groups, one of which may not be of fecal origin, had not been made, so in the tests these were not separated. It would seem that the cost of returning to this river and making a few tests to determine at least the order of magnitude of the spore former intensity during periods comparable with those for which the curves were computed would not be excessive and the value of such information great.

There still remains the problem of evaluating the residual or surface wash pollution. As to this, the only real hint found in the bulletin would seem to be the statement that total nitrogen was more nearly connected with surface run-off than with sewage pollution. It may be possible to connect up these effects, which are somewhat dependent on the same causes. Such evaluation is necessary, but will be difficult. Perhaps it must first be worked out on a smaller and less complicated stream.

It is generally supposed that B. coli (fecal) die less rapidly in cold weather than in warm. At first glance this phenomenon is markedly shown by the published curves. If, however, it is assumed that the upper portion of these curves is the nearest approximation to the colon death rate, no difference is shown.

As cold water is an environment inimical to these particular bacteria, it seems illogical that the colder and hence the more unfavorable environment the longer they should live, unless they are capable of passing into some "resting stage." Such stage is usually accompanied by a visible change in physical state—as by the formation of spores—which has not been reported for true B. coli. It would seem that an important piece of biological work was indicated here. In fact it seems that research into the "natural history" of these bacteria was imperative. The difficulty of such study will be great, but the importance of it is of the same order of magnitude.

Engineers, health officials, legislators and legal authorities now are in great need of some method of evaluating water from the quality standpoint, predicting the effects which proposed changes and restrictions will have on that quality and apportioning the responsibility for the pollution at any point in the stream among the various contributors of that pollution. These matters have already come to public attention in connection with the Chicago drainage canal, the Canadian boundary waters and the Passaic valley sewer; they are now being discussed in connection with the proposed Delaware river compact between New York, Pennsylvania and New Jersey, and they

are of constantly growing importance. In large measure we are now depending on the Public Health Service to obtain this information for us. For such work no organization is better fitted, but it is incumbent upon us all to support it in every way and also to aid by criticism and suggestions and by making known our ideas of what data we need.

For these reasons the writer has felt justified in expressing his views on this subject, although he realizes that the actual workers in the service know much more about these matters than he does. Nothing that he has said is intended to be derogatory of the excellent work that has been done and he will watch for further developments with profound interest.

THE NEW HAVEN WATER COMPANY[1]

By E. E. Minor[2]

The American Water Works Association in its membership and activities is country wide, so that I may be pardoned if I introduce these few remarks by a brief synopsis of the company I represent. The New Haven Water Company supplies water in southern Connecticut for a distance of about 20 miles along the shore extending some 18 miles inland to a population of about 250,000 people. The average consumption is about 30 million gallons per day, part of which is pumped and part supplied by gravity. Its watershed areas total 100 square miles and its storage about 4 billion gallons.

The topic given for discussion presupposes some outstanding event of interest in our work during the past year. I feel disposed to say we have none; yet I find something of interest in everything. I am therefore taking three things in our ordinary work and speaking briefly of these, for in each I feel there is some knowledge proved by experience.

Slow sand filter operation. We operate four acres of slow sand filters, which have been in continuous operation eighteen years. Our average rate is about 3 million gallons per acre, with a maximum of 4. The average run per bed per cleaning is 120 days. The loss of sand in 18 years is practically none. The average bacterial count on agar in the effluent is 5 per cubic centimeter. The raw water positive for coli 187 days during 1923, the filtered water negative throughout the year. The number of samples tested is about 4000.

The point of interest in this to me is the cleaning. We take off only the surface of the bed when we wash. This seldom exceeds 1 inch in thickness. We never disturb the body of the bed. The result is no stratification, minimum sand washed, and a continuity of action in the bed during its cycle.

Forestry work. We own about 18,000 acres of land and have

[1] Presented before the New York Section meeting, May, 1924.

[2] General Manager, New Haven Water Co., New Haven, Conn.

been fortunate in having the Yale Forestry School closely identified with us in our work. Is it possible to handle this kind of a reservation profitably? We think it is. We plant about 200 acres annually of coniferous trees, from stock raised by us. This work is cared for by our lake men. In addition they inspect for blight and insects, cut fire lines and patrol.

In marketing the crop we deal entirely with outside lumbermen under contract. This may be under a lump sum agreement or by the piece. We know our return before we start. Selective cuttings, the gradual development of certain species, the handling of woodland so that they are never bare or left to a promiscuous growth are all vital elements in this work.

Our experience shows the need of expert forestry supervision over a low return crop where each move must be taken with due consideration of its future effect, and operations must be conducted on a piece basis to be successful.

My third and last point has to do with our relation with state bodies and other utilities. Here I hesitate for no one knows what the future may show. We do have, however, in Connecticut in six or eight of the larger cities committees of engineers representing each public utility, formed for the sole purpose of keeping in close touch with each other on matters of common interest and which are dealing with such hard problems as electrolysis in a really constructive and remedial way.

State supervision of public service companies by the Utility Commission and the State Board of Health have been helpful to us in Connecticut owing to the high character of the men composing these boards. There are about 80 private water companies in the state. Through the Utility Commission questions of public relations, rates, etc. are fully cared for. The Board of Health has been of great help to us in matters relating to sanitation.

Supervision by state commissions of problems which are really larger than the locality directly concerned is being accomplished in Connecticut on broad constructive lines. Health is not a local matter, but is of vital interest to the State. Likewise water resources, rates, etc., are matters affecting neighboring communities all of which we are solving by mutual confidence and coöperation.

WATER SUPPLY SITUATION IN INDIANA[1]

By L. A. Geupel[2]

The water supply situation in the State of Indiana, as in other states, is a complex problem to discuss, especially as there are many classes and types of water supplies in general use. The most important are the public, semi-public and individual or private supplies. The public supplies represent the city or town, municipally or privately owned and controlled supplies; the semi-public supplies represent the church, school, industrial, institution, town well, park, hotel, tourist camp and other supplies; and the individual or private supplies represent water supplies owned by the individual in the rural districts and include the cisterns and wells located on private property usually not served by a public supply.

The public water supplies of Indiana are obtained from shallow and deep driven wells, dug wells, streams, natural lakes, impounded lakes and springs. Last year there were 223 public water supplies in the State having a daily average pumpage of 172,400,000 gallons of water, of which 73,848,000 gallons per day, or 43 per cent, were obtained from rivers and streams, 61,194,000 gallons per day, or 36 per cent, were obtained from driven wells, 30,520,000 gallons per day, or 17 per cent, were obtained from lakes, 3,863,000 gallons per day, or 2 per cent, were obtained from springs, and 2,968,000 gallons per day, or about 2 per cent, were obtained from dug wells. The total population of the cities and towns having public water supplies is 1,733,000, and they receive 172,400,000 gallons daily average pumpage, with a daily maximum pumpage of 245,840,000 gallons. The amount of water used per capita shows about 99 gallons per day for average use and approximately 142 gallons per day maximum use. The total number of services in use were 327,565 delivering daily approximately 526 gallons average per service and 745 gallons maximum per service.

[1] Presented before the Central States Section meeting, December 5, 1924.

[2] Director, Water and Sewage Department, State Board of Health, Indianapolis, Ind.

The municipally owned water supplies delivered approximately 91,982,000 gallons per day average consumption and a maximum daily pumpage of 136,958,000 gallons. The cities and towns served by municipal plants have a population of about 841,801 and the water was delivered through 164,429 services. The average daily consumption was about 109 gallons per capita with a maximum daily consumption of 163 gallons per capita. The services delivered about 558 gallons per service average daily and about 833 gallons maximum daily.

The privately owned and controlled water supplies delivered approximately 80,411,000 gallons per day average consumption and a maximum daily pumpage of 108,885,000 gallons. The cities and towns served by privately owned water plants have a population of 891,495 and the water was delivered through 146,287 services. The average daily consumption was approximately 90 gallons per capita with a maximum daily consumption of 122 gallons per capita. The services delivered daily about 550 gallons per service for average consumption and about 744 gallons maximum.

In a comparison of municipally and privately owned and controlled plants, from the above facts, it can be easily noted that the average daily consumption per capita in those cities and towns served by privately owned water plants is approximately 19 gallons per day, or 18 per cent, less than the average daily consumption in municipal plants.

The table below shows further classification of the public supplies in Indiana and the water used per capita by cities and towns with various sources of supplies.

SOURCE OF SUPPLY	POPULATION	GALLONS PUMPAGE		GALLONS PUMPAGE		SERVICES		
		Daily total	Average per capita	Daily total	Maximum per capita	Total number	Daily average	Daily maximum
Rivers	684,020	73,848,000	108	97,636,000	142	129,608	570	753
Lakes	208,718	30,520,000	146	41,100,000	197	32,248	946	1,274
Driven wells	740,957	61,194,000	82	96,227,000	123	150,328	407	640
Dug wells	39,475	2,968,000	75	4,977,000	126	4,261	700	1,168
Springs	51,126	3,863,000	75	5,903,000	115	11,120	347	530
Total	1,733,296	172,393,000	99	245,843,000	142	327,565	526	745

The table below covering the year's work ending October 1, 1924, shows the public water supplies obtained from various sources and the laboratory classification in regard to quality. Laboratory rating is given as per American Public Health Association standards. Bottled waters, ices and soda water beverages sold in state are added to following table merely for comparison.

Public water supplies

SOURCE OF SUPPLIES	NUMBER OF SAMPLES		PERCENTAGE	
	Good	Bad	Good	Bad
Rivers or streams (treated)	749	58	93	7
Rivers or streams (no treatment)	1	23	4	96
Lakes (treated)	221	17	93	7
Lakes (no treatment)	6	1	86	14
Driven wells	469	33	93	7
Dug wells	55	6	90	10
Springs (treated)	111	12	90	10
Springs (no treatment)	32	32	50	50
Bottled waters (sold in state)	71	2	97	3
Soda waters (carbonated and non-carbonated)	533	38	93	7
Artificial ice (sold in State)	275	17	94	6
Natural ice (sold in State)	35	11	76	24

In studying the above tables one can readily note that there is still room for sanitary work in Indiana. It is the writer's belief that the State of Indiana is no worse than the average state in America, yet there is still opportunity for improvement. Too many water works men still take chances and do not use good modern sanitary practice at all times. It is perhaps a coincidence that in the above classification the treated river supplies, treated lake supplies, driven wells, commercial soda waters and artificial ices average so nearly the same at 93 per cent good, 7 per cent bad.

The river sources, as is general in many sections of the country, cause difficulties in operation due to highly turbid raw waters in heavy recipitation periods and polluted raw waters in average dry periods.

Those public supplies on Lake Michigan located southeast of Chicago are dangerously affected by the very concentrated pollution of the southern end of Lake Michigan. So much has been written on the pollution of the southern end of Lake Michigan that the writer will not speak further of this condition except to say that, regardless of all sentiment or legal rulings, it is his opinion that some day indus-

trial growth will extend solid from the Illinois line to a point east of Gary.

With Chicago built solid along the west shore many miles north, industrial and domestic waste problems of Lake Michigan must be stopped in some way so that the water supplies taken from Lake Michigan can be treated in a safe manner. Aeration, sedimentation, filtration and chlorination are essential for those supplies taking water from the concentrated polluted area and, even with the above treatment, the water is not palatable due to industrial pollution yielding obnoxious tastes and odors.

The public supplies from driven wells deliver a more constant satisfactory water bacteriologically, but interference of wells, iron content, high carbonates, limitation of ground water supply and other conditions keep the efficient superintendent busy. Many of the driven well supplies are controlled by municipal boards and non-technical men in charge, who believe that if the supply is once satisfactory it will remain so, under any load conditions. It is the writer's belief that too many chances are taken with these sources of supplies. Iron content yields dead end water troubles in many cities and towns in Indiana. Iron removal will play a prominent part in future development in the State. Public opinion will require a clear water and many superintendents are studying this problem at the present time with the object of reducing the iron content. One hundred and sixty-five public water supplies obtained from driven wells have an average iron content of 0.93 part per million in the water delivered. One hundred forty-seven public water supplies obtained from driven wells have an average alkalinity of 298 parts per million, which requires softening for most industrial uses.

The public water supplies obtained from dug wells and springs are a constant source of hazard and close supervision must be maintained to reduce surface water pollution to a minimum. Spring supplies are intermittently bad and several of the supplies with spring sources are chlorinating the water delivered. All of these supplies should have chlorination for emergency.

The semi-public water supplies have only been investigated in several classes, namely, tourist camp and school wells. Limited personnel has made it impossible to cover this field up to the present time in a satisfactory manner. The investigations have been made of tourist camps in a thorough manner and the classification is listed below:

Tourist camp water supplies

SOURCES	NUMBER		PERCENTAGE	
	Good	Bad	Good	Bad
Deep driven wells	89	12	85	15
Shallow driven wells	13	17	43	57
Dug wells	4	11	27	73
Springs	10	7	60	40
Satisfactory city supplies	38	0	100	0
No water supply	0	7	0	100
Total	134	54	71	29

The above table shows that the semi-public water supplies in camps are a source of hazard. Tourist camps are now under strict regulation and those having bad water supplies are requested to obtain a satisfactory supply before the opening of the 1925 season for tourists.

Many school wells have been investigated and the results show that more attention must be paid by trustees in charge to obtain and maintain better school supplies.

Rural school water supplies

SOURCES	NUMBER		PERCENTAGE	
	Good	Bad	Good	Bad
Dug wells (less than 25 feet)	0	7	0	100
Dug wells (over 25 feet)	7	10	41	59
Driven wells (15 to 25 feet)	4	0	100	0
Driven wells (25 to 100 feet)	101	18	85	15
Driven wells (over 100 feet)	13	2	87	13
Total	125	37	77	23

If persons interested would only stop to think how many tourists cross Indiana, and how many children attend rural schools, the importance of hazard would be clear. Closer supervision must be exerted by the State Health Boards so that the traveling public, rural school children, and the remainder of the public using semi-public wells are more adequately protected from bad water conditions.

The privately or individually owned and controlled wells used on the farm and by the public not served by the public water sup-

plies need the constructive assistance of all health officials. The operation and maintenance of these sources of supplies are subject to gross negligence in regard to sanitation and good practice. In Indiana an attempt is being made to educate the individual to take proper care of his own well. Dug and shallow driven wells show a high percentage bad. In several states dug wells are generally condemned. In Indiana there are several counties where the average landowner cannot afford to construct driven wells and take the risk of not obtaining water. If water is obtained he may get such a high iron or chemical content as to make the supply unfit for general use. Properly constructed dug wells have given satisfactory tests and therefore the Board of Health permits their use but urges every precaution taken to keep out surface water and pollution.

The following table gives a classification of privately or individually owned and controlled water supplies showing the percentage good and bad. The table covers the examinations made during the year ending September 30, 1924:

Individually owned water supplies

TYPE OF SUPPLY	NUMBER		PERCENTAGE	
	Good	Bad	Good	Bad
Dug wells (all depths)	136	490	22	78
Driven wells (less than 15 feet)	16	9	64	36
Driven wells (15 to 25 feet)	86	55	61	39
Driven wells (25 to 100 feet)	440	131	77	23
Driven wells (over 100 feet)	131	34	79	21
Cisterns	20	31	39	61
Springs	45	51	47	53
Total	774	801	49	51

The above examinations were made from samples taken in sterile containers furnished by the Water and Sewage Department laboratories. The work in the laboratory is performed under the American Public Health Association standards.

In conclusion, it is hoped that the public may note the large differences between the controlled public water supply, the semi-public water supply and the individually owned water supply. It does not mean that the water works man can rest easily because it is hoped that the 93 per cent good can be raised to 98. Besides, as the case may be in other States, the laboratory receives more

samples from the satisfactory public water supplies, because the executives wish to know and also want the public to know the character of the water delivered; while the executives of the questionable or bad supply does not want to know the character of the water, nor does he desire publicity. Every effort will be made to examine all questionable water supplies frequently and, if executives do not coöperate, the Water and Sewage Department will be compelled to give full publicity to those cities and towns affected. The most effective supervision will be exerted to raise the quality standard of the semi-public and individual supply.

THE AMERICAN WATER WORKS ASSOCIATION AND THE WATER DEPARTMENT[1]

By C. B. Jackson[2]

I have spent some time in trying to decide just what the best method is of presenting this discussion in order to make it both interesting and instructive. I have decided to confine my remarks to two definite aspects, namely: the water works man inside the Association, and the water works man outside the Association, and, in order more forcefully to present the points I wish to make, with your indulgence, I shall take a retrospective view of the past in rather an abstract way.

In the long-forgotten past every man lived a life of independence; that is to say, he was under no obligations to anyone. He did not have to pay a municipality or corporation a price for water used, or electricity used. He did not have to pay his butcher, his baker, his tailor, or any others who nowadays administer to man's daily existence. He performed practically all duties necessary to his well being, and consequently lived a life unto himself, but, as time passed, it was found beneficial for mutual protection and advancement that men should gather themselves together, and, in so banding together there soon developed the necessity of laws and regulations, controlling their relationship to each other and their relationship to the community in which they lived. Of course, there had to be a surrender of a great deal of their individualism in order to blend their existence into a peaceful harmony, but it was found that a great many adverse conditions were overcome by the bringing together of their ideas and modes of living, and taking the resultant as the standard whereby they could advance their civilization. And after a careful analysis of the water supply business, considering it from the standpoint of evolution, we are led to the conclusion that it is no exception to this rule.

We find that a separate existence, so to speak, apart from the

[1] Presented before the California Section meeting, October 23, 1924.

[2] Superintendent, City Water Corporation, Fresno City, California.

practices and policies of others, is not compatible with an up-to-date water supply business, for, in this day and date, there is such a demand upon the individual to function, both from a physical and mental standpoint, that the highest class of physical health is necessary in order that the individual may meet these demands. This demand has become nation-wide and one of the fundamental requirements for the physical health of the individual is good, pure water, both for drinking and bathing purposes. Again it is evident that no individual, corporation, or municipality, is able to solve all the problems of development, purification, and distribution of water without the interchange of ideas and the assistance of experts in their particular line.

Speaking now directly to the water works man inside and the man outside the Association it is timely to use the illustration which one of our great political leaders used. It is a good illustration to develop this particular point. The successful lawyer is one who does not lose his temper and abuse the opposing counsel's witnesses on cross-examination, but the lawyer who carefully considers the feelings of the witness of the opposition in his cross-examination and carefully examines him as to his point of view, analyzing the position from which he saw a certain act about which he is testifying, developing the fact that the opposition witness was not in a position where he could see the act in question as clearly as he thought he could, and especially that he could not see the act committed from the point where he stood as clearly as his own witness had seen it, goes to the jury with no intention to discredit the opposition witness, no inference that this witness had perjured himself, but emphasizes the fact that his own witness was in so much better position to see this act, that, of necessity, the jury must be bound to take the testimony of his witness. That is the particular point I want to emphasize in this talk. The water works man who is a member of this Association is in so much better position to see and learn all the phases of water supply business that he has a great advantage, as to viewpoint, and should be believed when he gives testimony rather than the man outside of the Association who is not in a position to see these things so clearly. Inasmuch as the superintendent is usually the man of the hour in a water works business, stands between the people and the production of the water and its distribution, he should be in a position where his testimony cannot be shaken.

It is true that when we meet in convention one man's ideas may

predominate above those of others, but we all assemble here with our problems, with our ideas—and probably some of those ideas are pretty well fixed in our minds, especially as to there being only one way to do a certain thing. But when we come together in an organization of this kind I have always found that, no matter how sure I have been of a certain thing, by listening, giving ear to the ideas and experiences of others on the same line, I can learn a great deal about that particular subject.

I think this was especially impressed upon me as I began my educational career after I had reached my majority. In the study of physics this particular fact impressed me very much—we learned the fundamental law that a body set in motion moves forever in a straight line unless it is acted upon by some exterior force. We also learned another law in physics—that when two bodies moving in different directions are joined together the resultant direction of those two bodies is different from that which either of them had before. This resultant direction depends entirely upon the force with which each body is being projected—the one carrying the greater force will predominate in the resultant line; that is, to my mind, what we, in our convention accomplish. We achieve the resultant of the ideas of all those present; in other words, our ideas are interchanged. We put our ideas into a great boiling pot, build a fire underneath and boil and stir until the ingredients are all mixed and fully liquefied, then we draw off at the spigot the essence and get the cream of all those ideas, which is not an entirely different mixture from what we had before, but it is a modified resultant, a better and more concentrated mixture than was put in.

There are some who feel and some who have stated that now that we have met in this convention several times, we have finally reached a standardization of methods and ideas making future and further developments and meetings for the interchange of ideas unnecessary. Such, however, is not the case, because the enormous demand upon the individual, corporation or institution which administers to the human needs requires continual modification and progress.

We must continue to work to fill the demands of the future based upon our experience of the past, and I hope the time will never come when we can say that our work, or the institution which we represent is a finished product—that there is nothing more that can be done in order to make it more perfect that it is. When anyone reaches such a state of mind it is evident that he has reached a point where his usefulness is at an end.

Now, let us look for a moment at the position of the man on the outside of the Association. There is in the legal profession, written into all the laws of the land and handed down to us through the common law of England, the rule covering ignorance as a defense of an action. I think this law is practically copied from a passage of the Scripture, which, if I might quote without being criticized as to my exactness, is to the effect that a man is not responsible for what he does not know, but he is responsible for that which he may know. In a defense to an action at law, the Court will instruct the jury that the matter of notice is one which may determine whether the defendant may, or may not, be guilty of the offense charged. That is to say, that defendant may not have had actual notice of a certain act, or transaction, but he may have had such constructive notice as would have put a reasonable man upon inquiry and if he fails to make that inquiry and receive the notice which this inquiry would develop his lack of knowledge is no defense and he is held accountable; in other words, anything which would put a reasonable man upon inquiry, either actual, or constructive, is deemed to be sufficient notice. The water works man who is outside of this Association should be held accountable where he could come and receive the information and interchange of ideas as to up-to-date water works, especially as to sanitation and other important phases which are necessary. If he fails to do so, and the corporation or the municipality which he represents suffers by reason of his lack of knowledge of those things, this man should not be excused but should be held strictly accountable to his constituents both civilly and criminally for any ill effects resulting from his lack of knowledge.

In our proceedings in this convention we are, or should be, actuated or controlled by a motive for the common good.

If we follow, in our organization, these principles we shall soon have, in this wonderful state of ours, a unified idea of water supply development, sanitation, and distribution that will be conducive to the highest type of physical health in keeping with the progress of this state.

PROGRAM FOR STUDY OF WATERS USED FOR BOILER FEED

The Standardization Council of the American Water Works Association in May, 1924, approved a program to carry on a study of the treatment of water for use in steam boilers. The studies are to include the causes and prevention of corrosion of ferrous and non-ferrous materials used in steam station practice and other problems in railroad and central station practice. It was realized that studies so broad in scope as those encountered in the field of boiler water purification should be carried on jointly with other technical organizations directly interested in the subject. The work, therefore, will be done jointly with the National Electric Light Association, American Railway Engineers Association and possibly with one or two other organizations encountering problems of a similar kind.

The study is to be undertaken by nine committees, an advisory Committee and eight sub-committees. The personnel of these committees has been chosen after careful consideration. Members have been placed thereon because of special training or interest in the particular work assigned to them.

Each sub-committee will collect data relative to the subject assigned to it and will compile each year a report. The reports of the various committees, after review by the Advisory Committee, will be passed for publication. All reports passed by the Advisory Committee will be published in one or more of the journals of the technical societies participating in this study. Papers may be contributed by individuals to be embodied in the reports or published separately, as deemed advisable by the Advisory Committee, after conference with the chairmen of the sub-committee. No assurance may be given, however, that all papers contributed by individuals will be published.

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Mr. C. P. Van Gundy, Baltimore & Ohio R. R., Baltimore, Md.
Mr. C. F. Hirshfeld, Detroit Edison Co., Detroit, Mich.
Mr. A. L. Penniman, Jr., Con. Gas Elec. Lt. & Pr. Co., Baltimore, Md.
Prof. George C. Whipple,[1] Harvard University, Cambridge, Mass.
Mr. S. T. Powell, Chemical Engineer, Baltimore, Md. (*Chairman*).

The duty of this Committee shall be to direct the work of the sub-committees, to review and edit all reports and papers submitted for publication, and to determine where and when the material shall be printed. No information or data of an advertising nature shall be released for publication. No person shall serve on any committee as a representative of a commercial organization. Any person suggested, who is an employee of a manufacturing or commercial organization, may be appointed on a committee provided the appointment is made by one of the technical organizations affiliated in this work.

The Committee hopes that sufficient data will be obtained to warrant the preparation of a text on the subject within the next few years.

The chairman of all sub-committees will serve as ex-officio members of the Advisory and Editing Committee.

Sub-committee No. 1. Sedimentation With and Without Chemicals, Pressure and Gravity Filters and Deconcentrators, Continuous Blowdown Apparatus. A Study of These Methods Applicable to Steam Station and Railroad Practice. Mr. R. C. Bardwell, Supt. Water Service, C. & O. R. R., Richmond, Va., Chairman.

The work of this Committee is important and the procedure to be followed in the collection of operating data and interpretation requires close coöperation of all members of the Committee. Practice varies so greatly in methods of treatment that definite recommendations may be made only after practice in this country and abroad has been reviewed in detail.

[1] Deceased.

1. The value of sedimentation from a practical viewpoint, as a complete treatment, or when used in conjunction with filters. The Committee should determine the relative efficiency of continuous flow type basins or tanks in comparison with sedimentation basins operated on the fill and draw plan.
2. The Committee should establish the relative value of pressure and gravity filters for the removal of suspended solids, and make recommendations as to rates of flow through filtering material, as applied to industrial treatment. It should determine, also, the kind and size of filtering materials best adapted to such work, and other pertinent information which may result in a clearer understanding of the functioning of these appliances.
3. Deconcentration and continuous blow-down methods are being applied in steam station practice in this country and abroad. Much valuable information may be collected by the Committee with respect to these apparatuses. Special study should be devoted to the theory of the operation of appliances of this kind to determine their value in comparison with other processes in the removal of scale forming constituents from boiler water.
4. There is little information on the use of coagulants and their effect in steam station operation, based upon actual operating experience in this field. Pioneer work is possible and desirable.

Sub-committee No. 2. Water Softened by Chemicals (External treatment). Mr. C. R. Knowles, Supt. Water Service, Illinois Central R. R., Chicago, Ill., Chairman.

There are many chemical softening plants in use for the removal of scale forming ingredients from make-up water used for the generation of steam. The majority of these are employed for conditioning water for use in locomotives, although no small number have been installed at stationary steam stations. Railroad and stationary practice vary so greatly in respect to water treatment that this Committee may proceed more efficiently by considering the two problems separately. The standardization of equipment and of operation should be based upon the practices and the requirements of each utility.

The Committee may best formulate its own program of study,

although it appears that a study of the following items should prove profitable:

1. The chemical reactions to be considered in the light of present knowledge of physical chemistry, with special attention to the hydrogen-ion concentration of water and its influence upon the precipitation of hardening salts.
2. Compilation of operating data to determine the relative value of continuous and intermittent softeners.
3. Collection of operating figures showing the efficiency of subsidence tanks and basins in order to be able to submit recommendations for the more efficient design of basins for precipitation of solids and the removal of sludge.
4. The causes and prevention of retarded chemical reaction.
5. Standardization of rates of filtration employed for the removal of suspended solids from softened water.
6. The effect of silicious material as a filtering medium when used in conjunction with hot chemical softeners, and the value of non-silicious filtering material.
7. A consideration of the economic value of lime-soda softening preliminary to zeolite softeners or to evaporators.
8. Standardization of nomenclature in the field of softening of water by chemicals and of the apparatuses and appurtenances in use.

Sub-committee No. 3. Zeolite Softeners, Internal Treatment, Priming and Foaming, Electrolytic Scale Prevention. Prof. A. E. White,[2] *Director of Engineering, University of Michigan, Ann Arbor, Mich., Chairman.*

The adaptability of zeolite softeners and boiler compounds to the treatment of water has not been well defined. Much confusion exists as to the values and limitations of both methods. There are, however, specific fields of usefulness for these processes which may be noted by a group of men not influenced by commercial motives. The Committee should standardize the nomenclature used with these processes, determine the physical and chemical principles upon which the processes function, and allocate them to their specific spheres of usefulness in railroad and stationary steam practice.

There has been assigned to this Committee, also, the study of

[2] Acceptance not confirmed.

electrolytic processes for the prevention of scale formation and the causes and prevention of priming and foaming. Pioneer work in connection with a study of the electrolytic methods of scale prevention will be necessary, since the use of this method of treatment of boiler waters, at least in this country, is comparatively recent. There has been a great deal written on the causes of priming and foaming which takes place in the conversion of water into steam, but it is difficult to separate "the grain from the chaff" in respect to accurate data on this subject. Correlation and development of theoretical and operating data by the Committee may shed much light on these problems.

Sub-committee No. 4. Surface Condensers, Evaporators and Deaerators. Mr. A. L. Penniman, Jr., Supt., Steam Stations, C. G. E. L. & Pr. Co., Baltimore, Md., Chairman.

This Committee is to prepare for publication current information and data pertaining to the operation of these apparatuses and to designate their individual uses in steam stations. The Committee will give consideration to economic possibilities of the use of lime-soda and zeolite softeners as an adjunct to evaporators and deaerators.

The Committee may study with profit the causes of dezincification and corrosion of condenser tubing, the value of the Cumberland processes (an electrolytic method) for elimination of deposit on condenser tubes and the deaeration of water by iron and the applicability of the process to steam stations.

Sub-committee No. 5. Corrosion of Boilers and the Effect of Treated Water in Accelerating or Relieving these Troubles. Dr. H. Germain Creighton, Swarthmore College, Swarthmore, Pa., Chairman.

A study of the corrosion of metal in steam station practice should include the effect of both water and steam on ferrous and non-ferrous materials.

The removal of dissolved gases from feed water has done much to eliminate the corrosion of metal of boilers and appurtenances. There is little knowledge available, however, concerning the causes of corrosion in boilers and superheaters, using water that has been practically deaerated. Paul has indicated the possibility of production of organic acids under the influence of the high pressure and temperatures in boilers. He points to certain conditions where

formic acid has been produced from sodium carbonate with the production of free oxygen. Little, if any, work has been done in this country with respect to these conditions. With increasing tendencies toward higher temperatures and pressure in boilers, studies along these lines are desirable.

The corrosion and dezincification of condenser tubes has caused great financial loss, especially along the Atlantic Seaboard. These difficulties seem to be overcome by coating tubes with greater corrosion resistant metals, and by improvements in the structure of the metal itself. There is still need, however, for research in this field, since great financial losses are incurred yearly because of these replacements. The Committee should review in its early studies the proceedings of the Institute of Metals of Great Britain, where so much investigative work has been done in recent years.

Sub-committee No. 6. Embrittlement of Metals. Prof. A. G. Christie, Prof. Mech., Eng., Johns Hopkins University, Baltimore, Md., Chairman.

Recent study of the embrittlement of metal indicates that the contributing agent is high concentration of caustic soda in boiler waters, in the absence of other salts, principally chlorides and sulphates. There are some, however, who believe that the crystallization of boiler metal is caused by strains set up in the metal during operation. Studies, by a number of investigators, are in progress at the present time, and interesting data concerning the cause and prevention of this phenomenon are expected in the near future. This Committee may further the progress of the work by the inauguration of studies at universities equipped for work of this kind.

Sub-committee No. 7. Municipal Water Supply in Relation to Boiler Use. Mr. V. Bernard Siems, Water Engineer, Baltimore, Md., Chairman.

The primary function of this Committee will be the collection of data relative to the quality of water for steam making uses, supplied by municipalities, leading toward more intelligent control of public water supply in respect to this class of consumer. The second duty of the Committee should be a careful study of trade waste pollution of surface waters, in so far as such pollution is detrimental to the operation of industrial water treatment plants or surface condensers.

It is unreasonable to assume that the treatment of public water supplies should be carried so far as to meet the exacting demands for satisfactory boiler feed water. There is a growing tendency, however, on the part of municipal water treatment plant operators to lose sight of the industrial consumer's requirements, provided the sanitary demand as to quality of the water is fulfilled. As an illustration of this condition attention may be directed to the increasing popularity of the procedure of adding sulphuric acid to water prior to alum treatment with the final correction of the acidity by means of lime.

The recarbonization of softened water advocated by some engineers is also open to discussion in the above connection. These and other conditions are not the result of wilful neglect of the industrial user's water requirement, but to a lack of appreciation of them.

The elimination of the pollution of surface supplies from the water which is used for boiler feed or cooling purposes presents a more difficult problem, a study of which is valuable, in that it may bring to the attention of municipal authorities the importance of these problems in the operation of their own stations.

Correlating the work of this Committee with the Committee on Trade Wastes of the American Water Works Association is desirable to eliminate duplication.

Sub-committee No. 8. Bibliography. Mr. H. C. Parmelee,[3] Editor, Chemical and Metallurgical Engineering, New York City, Chairman.

The compilation of a complete bibliography of boiler feed water methods and allied problems is an undertaking of such magnitude that it may not be feasible at this time. The publication, at intervals, of current developments in this field, however, is an effective way of transmitting to plant operators information on progress in the industry. Much of this material is in the technical press which now reaches plant managers and operators. The abstracts, however, are generally intermingled with other technical notices and are frequently overlooked, or they are scattered through many journals or technical society proceedings. This is particularly so in the case of developments abroad. As an illustration, the following items may be noted, which have a direct bearing on feed water treatment and steam station operation, but which have received scant notice in the technical press.

[3] Acceptance not confirmed.

1. The determination of aggressive CO_2 as a control factor for corrosion.
2. The Cumberland process for the reduction of corrosion of surface condensers.
3. Continuous blow-down methods.
4. Combination lime-soda and zeolite softeners methods in steam station practice.
5. Combination lime-soda, zeolite softeners and evaporators.

These and many other interesting developments are occurring in this field, a knowledge of which is reaching comparatively few operators.

It is hoped that the Committee, to which this subject has been assigned, may be able, during the coming year, to start a current bibliography which should be so outlined that the undertaking may be broadened and completed as time proceeds.

DISCUSSION

Bronze Castings[1]

In the Committee's published report, referring to Board of Water Supply specifications for bronze castings, it is stated: "The prohibition of welding or burning for the patching of imperfect bronze castings is now absolute; no castings are known to have cracked that had not been burned, and there are few if any burned castings but have cracked, some cracks not developing for years." About four years ago the speaker critically examined some 250 bronze waterworks castings, 4 to 72 inches diameter. These castings had then been finished and subjected to hydrostatic test five to six and one-half years earlier, and had been in service and under pressure for four years. They had been made at a time when it was the standard practice of good foundries to repair either large or small defects in bronze castings by burning; that is, by flowing molten metal through the space in the casting from which defective metal had been cut out, until the edges of the casting were fused, making a complete union of the old metal with the new. Comparison with the logs of previous inspections showed that cracks in the burned castings had been developing progressively, both in number and in length, through a period of six years, even in those parts of castings, such as the dry ends of gate valves provided for future connections, which had not been under pressure since the shop acceptance test. Many small cracks had appeared after the castings were set and before they were put into service. Not all cracks had extended, some showing no changes in four years. Cracking had occurred in the simplest, as well as in the most complicated castings, provided they had been burned; it had occurred in castings from different foundries; and it had not occurred in unburned castings. It was unquestionably due to the burning, not to pressure, for working stresses are low. In a few of these burned castings, old cracks are known to have lengthened and

[1] Discussion of Progress Report of Committee No. 12, on Testing of Water Works Materials and Supplies. See Journal, May 1924, page 663.

new cracks to have appeared during the past four years, i.e., seven or eight years after the castings were made.[2]

With regard to galvanizing, the published report of this committee notes that the first step toward the formulation of standard specifications has been taken under the auspices of the American Engineering Standards Committee. The organization of a sectional committee on galvanizing has been slow, but the American Society for Testing Materials has assumed the sponsorship and will organize an entirely new committee to replace its former committee on galvanizing, the new committee being widely representative. I am assured that the American Water Works Association will be offered representation on the sectional committee which will do the actual work.

L. R. Wood.[3]

FILTER ALUM[1]

The Committee has made an excellent start and leaves no room for criticism in their progress report.

In their specifications for sulfate of alumina 0.5 per cent is set as the minimum excess of Al_2O_3 over that theoretically required to combine with the sulfuric acid. Most manufacturers will probably supply an alum at least this basic, and it is doubtful if a specified limit is necessary. The Committee may, of course, be in possession of data indicating that a slightly basic alum is preferable, and if such is the case there is no objection to this limit. My experience, however, tends to indicate that the water soluble alumina is what determines its effectiveness in forming a coagulation. If this is correct it seems that the basic requirement might be omitted from the specifications.

We have used alum containing as high as 10 per cent insoluble matter, and so long as there was the required amount of soluble alumina there seemed to be no decrease in its effectiveness. It is a fact, however, that most of the high insoluble alums are low in alumina. With equal prices the alum of low insoluble content is preferable, for it does not require continuous agitation and there is

[2] These castings are all still in service. In a few cases it has been thought worth while to repair castings by tap-battery on heavy fitted patch plates. Some others may require repair or replacement eventually. The material is so tough, however, that with occasional inspection, no apprehension for their safety need be felt.

[3] Assistant Engineer, Board of Water Supply, New York, N. Y.

less alum pipe troubles; but if there is considerable saving in price there is no great objection to a high percentage of insoluble matter. We have no specified limit.

Is it not time for the larger plants to purchase alum on a bonus penalty contract? In using alum from several different manufacturers we find there is a difference in the average alumina content. There is frequently a difference of over 0.2 per cent in the average. It might make a little more work for the laboratory, but would be a fairer basis of payment.

The only suggestion offered for the lime specifications is that there should be a specified limit for magnesium. This is very important in some sections of the country. It might be possible to have sufficient magnesia present to interfere with the slacking of the lime under the present specifications. Our limit is 2.0 per cent, and I understand this is the limit recommended by the National Lime Association.

It is hoped that the Committee will take up the methods of conducting tests in a later report.

JOHN R. BAYLIS.[4]

[4] Principal Sanitary Chemist, Water Department, Baltimore, Md.

SOCIETY AFFAIRS

CENTRAL STATES SECTION

The Central States Section met in Wheeling, W. Va., on December 5 and 6, 1924. With President Gensheimer in the chair, Thos. F. Thomer, Mayor of Wheeling, extended a most cordial welcome to the delegates of the Convention while they were in Wheeling, it being pointed out that a previous convention had been held in Wheeling exactly 10 years ago. The proceedings for the day were carried out in keeping with the program, except that Mr. Scotland G. Highland felt it necessary to decline. It was rather a notable incident that the Convention was honored by the efforts of the State Board of Health representatives from the five-states—West Virginia, Ohio, Pennsylvania, Michigan and Indiana—and the participation by these men of State authority was of considerable moment. The meeting was also made more successful by the presence of President Jordan, Vice President Huy, and Secretary Niesley of the parent association, who remained throughout the two day session. The officials and delegates of the Central States Section were pleased and honored by the presence of these men at the Convention of the Section. The delegates and friends of the Association were gathered together for a six o'clock dinner on Friday evening for the purpose of adding a touch of good fellowship to the Convention, and a most enjoyable time was had by all present. It was decided that the election of officers should be by mail ballot, and, therefore, the officers have not been selected for next year, but will be so selected by mail ballot at an early date. The Convention next year will be held at Erie, Pa., following a most cordial invitation by President Gensheimer.

The formal program follows:

December 5, Morning Session

Address by President Gensheimer.
Welcome by Thomas F. Thomer, Mayor of Wheeling.
Minutes of Last Meeting.

History of Wheeling Water Works, by J. S. Butts and Jack Shull.

Wheeling Filter Plant and Pumping Station, by J. F. Laboon.

Afternoon Session

Water Supplies of West Virginia, by E. S. Tisdale.

The Ohio Conference, by W. H. Dittoe.

The Sanitary Board of Pennsylvania, by W. L. Stevenson.

Water Supply Situation in Indiana, by L. A. Geupel.

Iodine Treatment in Michigan, by Edward D. Rich.

Development of Water Supplies in West Virginia, by Scotland G. Highland.

Manufacture of Cast Iron Pipe.

December 6, Morning Session

How Can Sectional Meetings Help the American Water Works Association? by Frank Jordan.

Fire Prevention and Protection, by J. J. O'Brien.

Coöperation Between Fire Chief and Water Works Superintendent, by J. I. Brennan.

Mine Waste and the Mine Operator, by J. R. Campbell.

South Pittsburgh Water Softening Plant, by Chas. E. Trobridge.

Afternoon Session

Sewage Disposal and Water Purification, by Philip Burgess.

Valuation of Water Works for Municipal Purchase, by E. E. Bankson.

Metropolitan Water Supply System, by Morris Knowles.

Corrosion, by E. C. Trax.

Election of Officers.

Inspection of Wheeling Filter Plant and Electric Pumping Station.

ABSTRACTS OF WATER WORKS LITERATURE

Frank Hannan

Key: American Journal of Public Health, **12:** 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Nature of Corrosive Action, and the Function of Colloids in Corrosion, with an Appendix on Terms Used in Colloid Chemistry. Guy D. Bengough and J. M. Stuart. J. Inst. Metals (advanced proof), 80 pp. 1922. From Chem. Abst., **16:** 3853, November 20, 1922. Electrochemical theory of corrosion gives satisfactory account of facts only under certain conditions. Theory of mechanism of colloid action is advanced and experimental results are reviewed in light thereof. Corrosion defined, in widest sense, as oxidation, which may be produced by chemical or electrochemical means; former, when reacting substance are in contact, and latter, when spatially separated. In latter case reacting substance must be capable of ionization and portion of energy of system appears as electrical energy. Purely electrochemical action may in certain cases be relatively unimportant. Thus cathode of cell of high voltage may be more rapidly attacked than anode, and anode at high voltage tending to force it into solution may be very little corroded, owing to scale formation. Further facts difficult to explain on purely electrochemical theory are: (1) Certain depolarizers do not increase corrosion, but actually inhibit it. (2) Conductivity of electrolytes is not directly connected with amount of corrosion. (3) Lambert's pure iron (probably purest metal ever produced) is readily attacked by sodium chloride and dilute acids. (4) Presence of ions of corroded metal should depress corrosion of most common metals, but there are numerous exceptions, and in some cases corrosion actually increases. Order of corrodibility of metals in distilled water, salt solutions, and non-electrolytes differs from electrochemical list, suggesting interfering factors such as scale formation. A main factor in corrosion by water and salt solutions is nature and distribution of products of corrosion, which may be far more important than any hypothetical distribution of cathodes and anodes in the metal. Effects of strain and impurity of metal are considered of fundamental importance from electrochemical point of view. Lambert's pure iron and lead were prepared with view of eliminating both these factors, but neither metal was incorrodible under certain conditions. Potential difference between strained and unstrained portions of same metal are usually very small, and unstrained (annealed) metal may corrode more rapidly than strained. In fact strain is a minor and ephemeral factor in corrosion in neutral solutions. Trace of impurity appears to assist local corrosion, but amount of corrosion is not proportional to amount of impurity. Even presence of graphite does not appre-

ciably stimulate rate of corrosion of iron. Effect of trace of impurity is probably trigger action. Local action at metallic surfaces may be produced in variety of ways at any selected points by modifying conditions external to surface, and is not mainly determined by presence of anodic areas in metal. Minute pores in metal may, however, give rise to local action, as shown by Seligman and Williams. According to electrochemical theory, action of oxygen is that of depolarizer, but it can be shown that oxygen has little depolarizing power at ordinary temperatures. Main function of oxygen in corrosion is to directly oxidize the metal, and, in some cases, the products of corrosion. Effect of over-voltage on corrosion phenomenon is briefly considered. Two chief types of corrosion are distinguished: (1) general type, usually characteristic of acid corrosion, and (2) local type, usually characteristic of corrosion in water and salt solutions. Latter is generally characterized by formation of adherent scale on metal which may contain colloidal material. Theory is developed regarding part played by colloids in corrosion, briefly outlined as follows: Metal immersed in water sends positively charged metal ions into liquid, and becomes negatively charged. In case of ordinary commercial metals, the metal also becomes superficially oxidized if dissolved oxygen is present. Hydroxide produced by this oxidation can take up ions given off by metal, and thereby passes into state of positively charged colloid, portion of which will diffuse away, permitting further reaction between oxygen and metallic surface, thereby reforming hydroxide film over latter. Oxidation is then stopped until this hydroxide can pass into colloidal state by acquiring positively charged metal ions. This, in general, does not take place until colloid initially formed has diffused into presence of electrolyte, when it is precipitated by the anion of dissolved salt, the cation neutralizing the charge on the metal corresponding to that of colloid. This allows metal to send more ions into solution and unchanged hydroxide thereby acquires charge. If colloid so produced can diffuse away, process can continue and corrosion develop. For steady corrosion, therefore, colloid must be produced under conditions which allow it to diffuse some distance before precipitation. If it precipitates directly on corroding surface, it will, in general, adhere to latter and stop corrosion. In case of a corrosion pit, first condition is fulfilled, since no precipitation occurs inside pit. It is only when the colloid diffuses through an aperture (generally very small) in the gel deposits at mouth of pit that it meets electrolyte and is precipitated. Such precipitation merely thickens external gel deposits. These gel deposits adhere directly to, and protect, the metal surrounding pit, thereby emphasizing local nature of the corrosion.—*R. E. Thompson.*

Rusting Under Protective Coatings. Hans Wolff. Farben-Ztg., **27**: 2889–91, 1922. From Chem. Abst., **16**: 3854–5, November 20, 1922. Condensed moisture retained in microscopic fissures and pores, as well as in imperfectly cleaned rusted areas, is chief cause of corrosion of metals under protective coatings. Besides being difficult to remove, this moisture is especially active because it is saturated with air. Iron plates were carefully cleaned and polished and dried in an oven, a number then being placed in enclosure where temperature was eventually lowered below dew point. While no condensa-

tion was visible, humidity measurements showed moisture deposition from air of 2 g. per cubic meter. The plates on removal were thoroughly wiped with dry cloth and painted at same time as oven-dried plates. After 3 months exposure, paint on "dewed" plates showed lack of gloss and pustules ranging from microscopic size to 0.25 mm. diameter, the larger pustules being filled with rust. Films on oven-dried plates were still in excellent condition. Removal of films showed that dry plates were free from rust while the others were badly rusted. Sand-blasted surfaces would be expected to rust more rapidly under coat of paint than hand-scraped surfaces as quantity of condensed moisture would be greater on relatively rough surfaces, which act as condensation nuclei. Preliminary experiments bear out this theory. Bridge was observed containing alternate sections where corrosion under paint had occurred. Entire bridge had been painted in dry weather but rusting sections were painted in morning when imperceptible film of condensed moisture was no doubt present.—*R. E. Thompson.*

Metallic Coatings as Rust Preventers. Coating with Lead, with Tin and with Aluminum. W. Lange. Z. Metallkunde, **13**: 267–75, 1921. From Chem. Abst., **16**: 3855, November 20, 1922. Corrosion experiments were carried out with distilled water, running water, 0.5 per cent salt solution, moist air and out of doors without protection. Lead was found to be more effective as rust preventer than zinc, regardless of method of application, being particularly suitable for protecting iron from sea water or chemical reagents. Galvanic tinning was found to be less effective than coating with lead or zinc, because of porous character of deposit. No direct comparative data with regard to effectiveness of tin-dipped iron is available, although it is known to be an excellent rust-proof material. Galvanic tinning is much cheaper but far less effective. Coating iron with aluminum by Schoop method was found to be very effective, but great care is necessary in application.—*R. E. Thompson.*

Installations for the Electrolytic Protection of Boilers and Condensers. Philippi. Arch. Wärmewirtschaft, **3**: 151–3, 1922. From Chem. Abst., **16**: 3993, November 20, 1922. Boilers are protected against corrosion by making them cathodes, anodes being iron pipe, set in, but insulated from the boilers. Voltage is 20 to 30 and current 0.02 to 0.04 amp. per square meter boiler surface. Anodes last approximately 4000 hours. Results of trial during several years have been satisfactory. Process reduces boiler scale, partly because of film of hydrogen formed on boiler.—*R. E. Thompson.*

Manganese Bronze in Engineering Work. Anon. Iron Age, **109**: 1513–5, 1922. From Chem. Abst., **16**: 3859, November 1922. Manganese bronze is non-corrodible in sea water and acid mine water and does not crystallize under vibratory stresses. This alloy has gained its greatest use and distinction (1) as castings for large engineering undertakings, e.g., lock-operating mechanisms in Panama Canal; various parts in aqueduct construction where combined strength, non-corrodibility, and resistance to seepage are required; (?) as material for propellers.—*R. E. Thompson.*

Hydrogen-Ion Concentration and Bacillus Coli. I. The Acid-Forming Ability of B. Coli. K. Scheer. Biochem. Z., 130: 535–49, 1922. From Chem. Abst., 16: 3921, November 20, 1922. Acid production of B. Coli in buffered sugar containing bouillon equals pH 5 within 10 hours, after which there is slight increase for 2 to 3 days, when acid production ceases. Final acidity is almost independent of initial pH of medium. Kind of sugar used has influence, each sugar having certain constant value; lactose 4.7, glucose 4.5. Final value is lowered by addition of lactic or acetic acid providing initial pH is not increased to, or over, final value ordinarily to be obtained. **II. The Bactericidal Effect of Certain Hydrogen-Ion Concentrations on B. Coli.** Ibid. 545–9. B. Coli is killed within 24 hours at pH 4.6 and 9.4. Acid forming properties of the organism will produce pH 4.6 in medium containing sugar.—*R. E. Thompson.*

Sterilization of Water with Tincture of Iodine. Batti. Rev. Hyg., 39: 319–20, 1919; Absts. Bact., 5: 144. From Chem. Abst., 16: 3990, November 20, 1922. Mixture of iodine (5 g.), potassium iodide (2 g.) and ordinary alcohol (100 g.) recommended for rapid sterilization of water—5 drops of mixture to liter of water, 5 drops sodium thiosulphte being added 20 minutes later to remove yellow color and taste. Six drops of each gave adequate treatment for soldiers' canteens. The solutions keep indefinitely.—*R. E. Thompson.*

The Purification of Waste Waters. Carré. Bull. suisse pêche pisciculture, 21: 1, 4–6, 1920; Bull. Agr. Intelligence, 11: 776–7, 1922. From Chem. Abst., 16: 3989, November 20, 1922. Colloidal clay is a natural purifier of water, purification being due to simultaneous precipitation of flocculated clay and fermentable organic matter which is essential cause of contamination of water. Salts of sodium, calcium, etc., must be present to effect flocculation. If sufficient liquid manure is added to test-tube of water to color it distinctly and tube then filled with water containing a little suspended clay, addition of few drops of salt solution will, after shaking and allowing to stand few minutes, precipitate the clay which will carry down all suspended matter and also organic coloring matter. Practical application outlined.—*R. E. Thompson.*

Distilled Water for Boiler Feed at River Rouge Plant. Anon. Power, 54: 998–1003, 1921. From Chem. Abst., 16: 3993, November 20, 1922. Illustrated description of boiler-feed system of new Ford Motor Co. Plant. The raw water contains considerable suspended and scale-forming material. An elaborate 2-effect high-heat-level evaporator system furnishes distilled water up to 25 per cent of boiler feed. Through a ring header system water is fed to sealed-off section in lower drum of each boiler element. Water from this section must pass up through 4 rows of tubes in the 3rd pass before entering general circulation. Impurities are deposited in outer surfaces of evaporator heating coils and in part stay in solution in evaporator shells, and are removed by scale cracking by steam. Data give boiler evaporation of 284,600 pounds net per hour, boiler steam 200 pounds, turbine condensate 200,400 pounds per hour at 90°F., auxiliary exhaust steam 4200 pounds per hour at atmospheric

pressure, distilled make-up 80,000 pounds per hour, and raw water temperature 80°F.—*R. E. Thompson.*

Filter Sand for Municipal Water Supply. W. M. WEIGEL. U. S. Bur. of Mines, Serial No. **2622**: 6 pp. 1924. General requirements, sources of supply, and methods of mining and preparation of filter sand are discussed and several typical specifications quoted. Rather high silica content is required; it is usually specified that not more than 2 per cent shall be soluble in hot dilute hydrochloric acid. Other specifications state that combined lime and magnesia, calculated as carbonates, shall not exceed 2 per cent.—*R. E. Thompson.*

Municipal works in Helensburgh, Scotland. JAS. N. STIRLING. Munic. Eng. **73**: 641, 1924. Growth of a variety of chara in the reservoirs, necessitating occasional emptying and cleaning, has been troublesome. The weed does not flourish on the pitched surface of the banks, in those parts occasionally exposed to air and sun, or at depths greater than 12 feet. Greater difficulty has been experienced from growth in mains of fairly soft nodules of rusty appearance, composed of hydrated ferric oxide and vegetable matter. In one instance a 5-inch pipe was rendered impenetrable to water under pressure of 75 pounds. Surfaces completely covered with nodules 1 to 1¼ inch in thickness are frequently encountered. The supply is unfiltered.—*R. E. Thompson.* (*Courtesy Chem. Absts.*)

Variations of Consumption of Water in Towns. JOHN BOWMAN. Munic. Eng., **73**: 668, 1923. Water used for trade purposes amounted in 1871 to 1.98 gallons per capita per day, or approximately 6 per cent of total consumption; it now amounts to 12 gals., or approximately 25 per cent of total. Requirements of cities in British climate considered by Parker to be 22–25 gals. per capita per day for all purposes, inclusive of 15 to 18 gallons for domestic use.—*R. E. Thompson.*

Conservation of Sources of Supply. JOS. PARRY. Munic. Eng., **74**: 43, 1924. Use of water for municipal supply considered of greater importance than use for power purposes. Proposal to appoint Water Commissioner for Gt. Britain, to be directly responsible to Ministry of Health, is discussed.—*R. E. Thompson.*

Reinforced Concrete Construction. A. LEGAT. Munic. Eng., **74**: 141, 1924. Concrete may be made absolutely waterproof by careful selection of materials and thorough mixing and ramming. Joint between different days' work requires special attention; but if concrete surface is well cleansed and flushed with cement compo prior to placing new work, excellent results may be obtained.—*R. E. Thompson.*

A New Type of Multi-Purpose Pump. Munic. Eng. **73**: 525, 1924. "Aquatole" endless chain pump described. Mechanism consists essentially of endless chain of superposed helical coils which revolves on pulleys. When chain drawn through water, latter is held in coils until it passes over top roller, when it is released. High efficiency maintained cannot be equalled by ordin-

ary pump. A special feature is its adaptability for use in bore-holes.—*R. E. Thompson.*

Some Physico-Chemical Factors in Water and Sewage Treatment. E. K. Rideal. Munic. Eng. **73**: 558, 1924. A general discussion.—*R. E. Thompson.*

Water Power in Greenock. J. MacAlister. Munic. Eng., **73**: 667, 1924. Undertaking now consists of 19 reservoirs, having total storage capacity of 4230 million gallons, and catchment area extending to 10,000 acres. After being used for generation of power, water is filtered and distributed for domestic consumption.—*R. E. Thompson.*

Littleton Reservoir. H. E. Stilgoe. Munic. Eng., **74**: 20, 1924. Construction of, described. Water surface is 723 acres, and approximate capacity, 6750 million gallons. Cf. this Journal, **9**: 954; **10**: 160, 936.—*R. E. Thompson.*

Getting the Public to Work with You. A. C. Joy. Fire & Water Eng., **75**: 737, April 16, 1924. First step in creating favorable public opinion is in hands of personnel. Every employee should realize that success of organization lies in impression he personally leaves with consumer. Public utility's position in community it serves is strong, or otherwise, as public opinion is for, or against it. Much of animosity and distrust existing is due to ignorance or lack of understanding. Employee should be familiar with methods of operation, costs, rates, and all other information which may, if properly set before consumer, remove suspicion. Press furnishes best of remaining opportunities for public contact; but use of this channel requires careful study and still more careful handling. Publicity work may be handled as news, or as advertising; latter is better, reaching more people. Dealings with press should be carried on through organized department of trained publicists.—*Geo. C. Bunker.*

The Service Charge; Why It Is Desirable. C. N. Crowley. Fire & Water Eng., **75**: 746. April 16, 1924. Extension to water works of St. Paul, Minn., resulted in increased operating expense, interest, and sinking fund charges necessitating increase in revenue, which was barely sufficient for operation under old conditions. After thorough consideration by board of water commissioners, it was decided that any large increase of present meter rate, 6 cents per 100 cubic feet, would occasion distress to many people so unfortunate as to overlook or neglect repair of leaky fixtures, or in event of temporary absence from property; and that proportionate charges should properly attach to first problem of procuring water and carrying it to common source of supply, and, in equity, be carried as far as possible as separate fixed charge on each service supply. It was decided therefore to add monthly service charge to each meter bill according to size of meter; for example, 25 cents to $\frac{5}{8}$-inch, 35 cents to $\frac{3}{4}$-inch 60 cents to 1-inch, etc. Service charge continues while meter remains on property and is only cancelled on written order of property owner, or agent, access being given to property for removal. Fractional charges are made for $\frac{1}{2}$ month, but no less.—*Geo. C. Bunker.*

The Water Treatment Plant in Theory and Practice. Paul Hansen. Fire & Water Eng., 75: 779, April 23, 1924. Although referring specifically to filtration plants, this very timely paper should be read by all engineers who design water works because in the past and even at the present time many changes have to be made in plants by men assuming charge of operation as result of the designer's unfamiliarity with ordinary details of operation. Every engineer who is called upon without previous experience in operation, to design a filtration plant, should consult with a man of varied experience in operation. Author makes point that, in designing water purification plants, engineer should try constantly to keep operator's point of view in mind and to secure accessibility, flexibility, reliability and durability. Of these, operator appreciates accessibility above all, but flexibility is also very essential. Paper was read before Texas Short Water Works School at Waco, Texas.—*Geo. C. Bunker.*

This Town Takes No More Chances on Big Fires. Thomas H. Allen. Fire & Water Eng., 75: 873, April 23, 1924. Ridgely, Tenn., population 1000, voted $85,000 bond issue to provide adequate water supply for fire protection, sewer system, and municipally owned electric light plant. Original electric plant was repaired and converted into fire proof structure; electrical system reconstructed and 2 Fairbanks oil engines and generators installed. Underwriters required pumping capacity of 250 g.p.m. and storage capacity of 75,000 gallons on 100 foot tower. Water is pumped to elevated steel tank from well by Layne vertical shaft motor-driven deep well centrifugal pump. Section of roof and door, with permanent steel derrick mounted above roof enable pump to be pulled from well when repairs necessary. Electric fire alarm siren is mounted on top of derrick. All machinery was set above flood level. Every house has water and sewer connection. Illus.—*Geo. C. Bunker.*

Some Helpful Suggestions for Setting Water Meters. John L. Ford. Fire & Water Eng., 75: 688, April 23, 1924. Meters should not be installed in places, or under conditions, which defeat one or more of three requisites of meters and metering; protection, accuracy, and availability. Meter should be safe from freezing, from mechanical damage, and from tampering. It should be set so as to remain as long as possible what meter should always be—instrument of precision. It should be as easily read and cared for as possible. Curb is logical location. In discussion of type and setting of outdoor meter box several points are brought out concerning protection against freezing. Outside setting of meters was originally approached by practical water works men with considerable skepticism. Time has proved that such settings, properly made, afford degree of protection not obtained in basements. Illus.—*Geo. C. Bunker.*

Financial Problems the Water Company Is up Against. Waldo S. Coulter. Fire & Water Eng., 75: 851, April 30, 1924. Short discussion of the financial problems of privately owned water companies. As solution available to certain classes of public utility corporations, sale of preferred stock to consumers or to wage-earning class is mentioned. This has advantage of

increasing junior investment without danger that original owners will lose control, while securing self-interest of many voters against unfair treatment by politicians. With its stocks well distributed among voters, it is reasonable to suppose that company might be more favorably treated in matter of rates. The work of public utility commissions will be made easier if public opinion is sufficiently intelligent to be fair to public utility corporations.—*Geo. C. Bunker.*

Placing a Municipal Water Works on a Sound Paying Basis. Glenn B. Meagher. Fire & Water Eng., **75**: 447, March 5, 1924. During 13 years of municipal ownership, Ottumwa, Iowa, water works has paid all current expenses, replaced all equipment, including new dams and hydro-electric development, retired \$64,000 of purchase bond issue of \$275,000, which falls due in 1931, set aside further \$41,000 for same purpose, and greatly expanded its system. 27.2 miles of pipe line have been added, 199 new hydrants and 6 new motor driven pumps installed, 2 new concrete dams built, hydro-electric plant constructed, sedimentation basin and filter plant installed, including modern steam turbo-generator. Number of services has increased from 1200 to 3300 and meter rates have been reduced 16 per cent.—*Geo. C. Bunker.*

Use of Copper Sulphate for Removing Tastes and Odors. E. Sherman Chase. Fire & Water Eng., **75**: 451, March 5, 1924. Two applications of copper sulphate were made to Cape Pond, source of supply of Rockport, Mass., in May and June, 1922. During first treatment, 2¼ pounds per million gallons, or 0.28 p.p.m., were distributed by towing bags with boat. Reduction in organisms of slightly over 50 per cent was obtained; no fish were killed; water as drawn from taps was satisfactory in appearance and taste. To effect further reduction, second application was made five days later at rate of 5 pounds per million gallons or 0.6 p.p.m. Majority of organisms were destroyed, but dead fish appeared on first day following treatment and continued to appear during next five days; in all about 1800 fish, ranging downwards in size from length of 8 to 12 inches, were removed. Application on November 3 of 4¼ pounds per million gallons, or 0.5 p.p.m., so reduced the growths that no further tastes and odors were experienced. On August 14, 1923, applicaton of 6 pounds per million gallons, or 0.71 p.p.m., was made with result that very low counts were obtained in latter part of September. No large fish were killed, but numerous minnow succumbed on shallows. Systematic flushing of mains was carried out in August and November, 1922, and repeated in May and August, 1923. Combined result of these remedial measures was to give Rockport a supply of reasonably satisfactory physical quality, distinctly superior to that of previous years. Illus.—*Geo. C. Bunker.*

Oil Engines That Have Seen Long Water Works Service. J. H. Bender. Fire & Water Eng., **75**: 495, March 12, 1924. In power plant of Clayton, N. M., municipal water and light department, there are two 90 h.p. and one 180 h.p. oil engines. They are single cylinder, horizontal, 4-cycle engines with air injection of fuel, cylinder compression of about 275 pounds per square inch, with ignition assisted by hot ball. Each engine is belted to a 2200 volt,

3 phase, 60 cycle alternator. First 90 h.p. unit was installed in 1911, second in 1912, and 180 h.p. unit in 1917. Fuel oils ranging from 24 to 32 degrees Bé. are used. Oil reclaimer purifies all used lubricating oil for further use. From power plant, transmission line runs to pumping station of water department, about 3 miles distant. Small triplex and centrifugal pump, each direct connected to motor, are operated by remote control from power plant, thus eliminating operators at pumping station. No serious difficulties or troubles have developed during four years' operation. Considering that engines are belted to generators and are operated for much of the time at load factors ranging from 50 to 75 per cent fuel consumption is very good. Best economy during last two years was in October, 1923, when 8.83 kw. hours were obtained per gallon of fuel; lowest, in May, 1923, was 7.63 kw. hours per gallon.—*Geo. C. Bunker.*

When Fire Pressure Is Needed Use Pumpers. William Luscombe. Fire & Water Eng., 75: 539, March 19, 1924. In Gary, Indiana, pressure is increased to 100 pounds when fire alarm sounded; which is perilous and unpractical because of repeated strains thereby thrown upon distribution system. Excess pressure required to fight fires can best be supplied by portable pumpers. The Gary supply is taken from Lake Michigan through reinforced concrete tunnel, 6 feet inside diameter, from submerged crib about 1½ miles from shore, in 44 feet of water. Tunnel, about 3 miles long, terminating in vertical shaft, upper part of which is enlarged and used as suction well, has capacity of 80 m.g.d. 6 motor driven pumps, 3 for general use and 3 for fire pressure, have total capacity of 38 m.g.d. Average daily pumpage in 1923 was 5 m.g.d., with maximum of 9 m.g.d. Practically all services are metered. Water is not filtered, but is treated with liquid Cl at rate of 2 pounds per million gallon.—*Geo. C. Bunker.*

Making Figures Talk in a Water Works Report. Fire & Water Eng., 75: 543, March 19, 1924. Tables and data from annual report of water department of Pasadena, Cal., for fiscal year ended June 30, 1923. Net operating revenue increased $70,772.45, or 49.2 per cent, from previous year, as result of purchase of three private companies and continued large natural growth. Due to increased gravity flow, pumping operations and expenses were reduced. During year, 1 m.g. reservoir was constructed on top of steep granite hill at cost of $14,255.22; it was excavated in decomposed granite and lined with 1½ inch reinforced gunite. Tables are given showing: cost per foot of cast iron main construction by fiscal years; cost of pumping water from 12 stations; details of 19 pumping stations.—*Geo. C. Bunker.*

Why and How Memphis Water System is Being Replaced. F. G. Cunningham. Fire & Water Eng., 75: 591, March 26, 1924. Present supply obtained from three groups of wells, each group being pumped by a different method. Iron content varies widely in different wells, as much as 6 p.p.m. being found in Auction Ave. group. Carbon dioxide content, although variable, averages about 100 p.p.m.; about 80 per cent was removed by air-lift pumping which also changed the dissolved iron into a comparatively stable colloidal condition

which would not settle out upon protracted standing. Deficiencies of present supply are inadequate capacity, lack of reservoir storage for fire protection, high operating costs, poor physical condition of certain parts, lack of treatment works for iron and carbon dioxide removal, and, at Auction Ave., potential danger of contamination by river flood waters. It was decided to abandon wells now in use and build two new works, one now and the other about 1930. New pumping station, reservoir, and treatment works are located about 4000 feet east of Auction Avenue station. There are 23 wells; average depth, 450 feet; casing diameter, 12 inches; space between wells about 500 feet; each well discharges into open concrete tank in brick house which covers it; average daily capacity is 18 m.g., maximum, 25 m.g.; air-lift pumping will be used. Collecting mains discharge into equalizing basin from which water is lifted by secondary centrifugal pumps, directly connected to reaction water turbines, to aërator, where it is distributed to 40 shallow boxes with perforated bottoms from which it trickles downward through 4 successive 10-inch layers of coke, supported on trays with clear spaces between of about 9-inches. About 9 feet of head are required for aeration; maximum rate of flow will be 30 gallons per minute per square feet of distribution box area. From aërator, water will pass through 8 rapid sand filters with nominal capacity each of $2\frac{1}{4}$ m.g.d. Underdrains are perforated pipe laterals connected to concrete box manifolds, cast monolithically with filter floors. Filtered water will flow into open concrete distribution well in pumping station from which 2 concrete conduits run to suctions of high service pumps and a third to storage reservoir, with capacity of 10 m.g., constructed of concrete, with roof of the flat slab type covered wth 2 feet of earth. Pumping station is 225 x 125 feet in plan by 50 feet high. It contains: 4 air compressors, each with capacity of 2700 cubic feet per minute; 2 cross-compound pumping engines with capacity of 15 m.g.d. under 200 feet head; 2 centrifugal pumps of same capcity driven by steam turbines; 2 small generators; 4 boilers equipped with superheaters and underfed stokers, each of 350 h.p. nominal capacity. Cost of new works will be approximately $2,800,000.—*Geo. C. Bunker.*

The Corrosion of the Lead Sheaths of Cables by Water Seeping Through Concrete. Geo. C. Bunker and A. H. Khachadoorian. Jour. Worcester Polytechnic Institute, **26**: 12, November, 1922. Between Sept., 1916 and June, 1917, six breakdowns occurred in control cables in middle cross-over tunnel at Miraflores locks of Panama Canal; in July, 1921, a seventh failure occurred. These cables are covered with lead sheath $\frac{1}{16}$ inch thick and are run through vitrified clay ducts buried in concrete. First six failures occurred in vertical runs in outside rows of ducts on north sides of east and west shafts leading to middle cross-over tunnel. It was found on exposing cables by breaking into ducts that water was continually dripping from them, as result of seepage through concrete from upper lock chambers. It was considered that chemical action of this water was responsible for trouble. Two samples of drip from cables contained an average of 1825 p.p.m. of caustic, or hydroxide alkalinity and only 11 p.p.m. of carbonate alkalinity. Experiments demonstrated that brackish waters of lock chambers will, after saturation with calcium hydroxide from concrete, quickly attack lead sheath. Another experiment demonstrated

that erosion of lead would take place in absence of electrolysis. In August, 1920, lead sheaths of cables running under Gatun locks were found to have been corroded by drip from ceiling and walls of concrete tunnel. In first half of 1920, lead sheath of telephone cable was found to have been corroded as result of chemical action of water entering vitrified clay ducts through walls of surrounding concrete conduit. In this case spots of erosion were quite regularly spaced at intervals corresponding to joints between ducts. Not only must unprotected lead sheathed cables be kept away from concrete exposed to action of water, but they must be kept out of vitrified clay ducts through joints, or into ends, of which, seepage through concrete or cement may enter. This applies not only to cables run through concrete walls, but also to those laid in ducts in concrete conduits under ground. Sea water, lake water, ground water, or rain water which seeps through concrete or cement mortar will pick up enough hydroxide or caustic alkalinity to erode lead sheaths on which it drips, or along which it may run. Illus.—*Geo. C. Bunker.*

Heat Loss Due to Sensible Heat in Boiler Refuse. E. Ogur. Power, 60: 8, 287, August 19, 1924. Loss due to sensible heat in refuse is not ordinarily accounted for in making heat balance of boiler. "This loss is fourth in magnitude of accountable losses and third in magnitude of controllable losses. It may be as high as 4.5 per cent and fully half of it is preventable." Methods for its determination are given.—*Aug. G. Nolte.*

Cost of Pulverized Installations. Power, 60: 8,290, August 19, 1924. Chart, prepared from data given at First World's Power Conference by builder of pulverizing systems, is presented, which, though applying to particular make of equipment, is yet fairly representative.—*Aug. G. Nolte.*

Chlorine Treatment for Circulating Water. Power, 60: 8, 305, August 19, 1924. Process for treatment of steam-engine and turbine cooling water with chlorine, to prevent fouling of condenser tubes, has been developed by W. Paterson, London, England. Amount of chlorine used does not exceed one-third of part per million. This is claimed sufficient to prevent growth of vegetable and animal organisms, which form an effective non-conducting deposit on inside of condenser tubes.—*Aug. G. Nolte.*

Power Plant of Milwaukee Sewage Disposal Works. Power, 60: 9,316, August 26, 1924. Comprehensive description, together with outline of adopted form of activated sludge process.—*Aug. G. Nolte.*

Operating a Diesel Power Plant. R. G. Melrose. Power, 60: 9,324, August 26, 1924. Observations of running conditions will often suggest minor adjustments to increase efficiency. Hindrances to smooth operation may develop without warning. Examples of such, culled from wide range of personal experience are discussed.—*Aug. G. Nolte.*

Tests of Mechanical Soot Blowers. R. June. Power, 60: 9,326, August 26, 1924.—*Aug. G. Nolte.*

Water Cooled Furnaces Make Records at Hell Gate. W. E. Caldwell. Power, 60: 10,354, September 2, 1924. Construction of furnace is illustrated and described. Deterioration greatly reduced. Combined efficiency of 92.7 per cent obtained.—*Aug. G. Nolte.*

Cross-Compound Impulse Turbine Geared to 4000 kw. D.-C. Generator. Power, 60: 10,361, September 2, 1924.—*Aug. G. Nolte.*

Reconnecting Direct-Current Machines—Changing Speed and Voltage. A. C. Roe. Power, 60: 10,363, September 2, 1924. Computations for new windings for shunt, compound, or series motor, to meet changes in speed and voltage.—*Aug. G. Nolte.*

Present Practice in Steam Generation in the United States. Dr. D. S. Jacobus. Power, 60: 10,368, September 2, 1924. Extract of paper read before First World Power Conference, London, July 1, 1924.—*Aug. G. Nolte.*

Diesel-Engine Standby Plant at Iron River, Michigan. Power, 60: 11,390, September 9, 1924. Two vertical Diesel engines of two-stroke-cycle type, each rated at 1250 h.p., form prime-mover equipment of new plant, and drive 1075-kva. 60-cycle 6600-volt three-phase generators with direct connected exciters. Fuel oil is delivered from tank cars into a ground embedded concrete tank, 66 feet in diameter and 20 feet deep. Water supply is purified. Cost of plant was $187.74 per kilowatt of generating capacity. Average economy 0.676 pound of oil per kilowatt-hour.—*Aug. G. Nolte.*

Notches in Packing Reduce Wear and Scoring of Shaft when Gritty Substances are being Pumped. S. H. Samuels. Power, 60: 11,395, September 9, 1924. Notches allow circulating water in gland to wash sand and grit into pump thereby restricting their passage along shaft.—*Aug. G. Nolte.*

Pipe Joints for High Pressure and Temperatures. Power, 60: 11,396, September 9, 1924. Various types are illustrated and described.—*Aug. G. Nolte.*

Tests to Make on Direct-Current Motors when Putting Them into Service. C. A. Armstrong. Power, 60: 11,398, September 9, 1924. Methods to determine if connections on Series, Shunt, and Compound Motors are correct before putting them into service. How to test the polarity of Series- and Shunt-Field Coils in Compound Motors.—*Aug. G. Nolte.*

How To Regulate Underfeed Stokers. J. E. Richardson. Power, 60: 11,401, September 9, 1924. Practical pointers bearing on efficiency of combustion.—*Aug. G. Nolte.*

The Boiler-Water Problem. W. M. Booth. Power, 60: 11,410, September 9, 1924. Treatment of water of various degrees of hardness for boiler purposes. Proper proportioning of chemicals is very important. Boiler scale is avoidable evil.—*Aug. G. Nolte.*

Improving the Lubrication System of Steam Turbines. C. C. Brown. Power, **60**: 11,420, September 9, 1924. Reciprocating pump and oil cooler prevent excessive oxidation in continuous filtration system in plant of Western sugar refinery. Leakage of oil from system is small. Standard practice at plant is to add one-half barrel of fresh, medium-heavy, turbine oil to system at monthly intervals, drawing off similar quantity for settlement, filtration and subsequent reuse. Sudden darkening in color, or formation of petroleum acids, is danger signal warning of oil oxidation or breakdown. Describes other oil troubles and their causes in steam turbines, and general operation of forced feed lubricating system.—*Aug. G. Nolte.*

Tests of a Steam Generating Unit at a Municipal Power Plant. J. E. Woodwell. Power, **60**: 12,446, September 16, 1924. After boiler plant of new municipal power plant at Lansing had been in operation for extended period, one unit was subjected to thorough test conducted jointly by engineers respectively of equipment manufacturers and of owners, and by the consulting engineer. Test was made under conditions obtaining in regular operation. Guaranteed performance was exceeded. Complete results are shown graphically and in tabular form and some of the more important conclusions summarized.—*Aug. G. Nolte.*

Locating Faults in Synchronous Motors. A. A. Fredericks. Power, **60**: 12,451, September 16, 1924. Difficulties occurring in operation of synchronous motors are discussed and causes of heating in bearings and windings explained.—*Aug. G. Nolte.*

Worthington Builds Double-Acting Two-Stroke-Cycle Diesel Engine. Power, **60**: 12,457, September 16, 1924. Design of this engine is illustrated and described.—*Aug. G. Nolte.*

Protection of Small Water Supplies Used by Railroads. O. E. Brownell. Public Health Reports, **39**: 36, September 5, 1924. Many underground supplies used by railroads in Minnesota for drinking and culinary purposes are obtained from wells equipped with simple hand pumps. Difficult to maintain satisfactory bacteriological conditions in supplies of this type: whereas larger installations, properly located and constructed, have been satisfactory year after year. Leakage into supply is chief source of trouble. Proper care and maintenance is of extreme importance. Contamination may be greatly reduced, or avoided, by suitable location and installation. Properly constructed wells are illustrated and described and some defects frequently found pointed out.—*Aug. G. Nolte.*

Questions and Answers. Franklin Vanwinkle. Power. Subjects as follow: **60**: 8,303, August 19, 1924. Reinforced Concrete Foundations; Cooling and Utilizing Heat of Oily Drips; Gage Cocks in Water Columns; Locating Striking Points to Show Piston-Travel Clearance; Shorter Cutoff Required When Operating Condensing; Loss from Twice Handling Return Water; Jet Pump Made from Pipe Fittings. **60**: 9, 9,342, August 26, 1924. Coal Gas

from Banked Fire; Firing Return-Tubular Boiler through Side Wall; Advantages of Multiple Valves for Pumps; Relative Economy of Injector and Feed Pump; Bagging and Blistering; Sources of Loss from Cylinder Condensation; Cleaning Injector Tubes; Bent Rocker on Single Valve Engine; Resistance to Flow of Steam by Elbows and Globe Valves; Heating Surface of Return-Tubular Boiler; After Condenser; Brine Circulation for Separate Refrigerating Rooms; Evaporation of Water with Heat of Exhaust Steam. **60**: 10,380, September 2, 1924. Finding Location for Spools of Duplex Pump; Best Vacuum for Suction Lift; Required Size of Pop Safety Valve; Efficiency of Butt and Double-Strap Joint Double-Riveted; Relief Pressure of Superheater Safety Valve. **60**: 11,430, September 9, 1924. Position for Eccentric when there is a Double Rocker; Operating Induction Motor with Rotor Connected to the Line; Laying up Steam Turbines; Noise and Breakage of Diesel Engine Piston Rings; Exhaust Pipe Sizes; Balanced Draft; Grooving of Boilers; Cause of Generators Not Operating in Parallel. **60**: 12,470, September 16, 1924. Rust Spots on Exhaust Valve Seate; Refrigeration from Brine Coil; Utilization of Exhaust in Laundry; Why Six-Phase Rotary Converters Are Used; Fuel Saved in Refrigerating Plant from Use of Cooling Water of Lower Temperature; Determining Length for Connecting Rod.—*Aug. G. Nolte.*

Foaming of Boiler Water. C. W. Foulk. Ind. & Eng., Chem., **16**: 11, 1121, November, 1924. Terms "foaming" and "priming" have been variously and indiscriminately used in the past to describe one or more of three distinct boiler phenomena, viz: (1) actual foaming at water surface, (2) more violent ebullition, with projection of slugs of liquid into steam pipe, (3) combination of first and second phenomena, when whole mass from bottom up is filled with fine steam bubbles causing expansion, raising of water level, and entrainment of liquid with steam. Soluble salts have most generally been held responsible; but neither they alone, nor finely divided insoluble matter alone, will cause foaming. A combination of the two, however, results in foaming, degree of which depends upon, and is, within limits, proportional to concentration of either. The finer the insoluble matter, the greater the foaming effect for given weight of material. The greatest foam producers, boiler scale and pulverized limestone, were, however, violently effective even when all particles were retained on 40 mesh sieve. Experimental data indicate that concentration of soluble salts may cover a considerable range without causing foaming, provided insoluble matter does not exceed 500 p.p.m., nor will any reasonable amount of insoluble matter cause foaming provided soluble solids do not exceed 500 p.p.m. Change of pressure (0.3 to 3.5 atmospheres) apparently has no effect upon character or intensity of foaming, except that sudden reduction in pressure will cause instantaneous violent ebullition for the moment. Raising, or lowering, of surface tension of liquid will always produce foam if stabilizing agent, such as finely divided solid is present. All combinations of soluble and insoluble matters in water which caused foaming during boiling likewise foamed when air was blown through in fine bubbles at ordinary temperature. Waters containing organic matter in solution failed to foam until insoluble matter added. Aluminum hydroxide produced no foaming in either alkaline, acid, or neutral solution. All classes of foaming caused by combina-

tion of soluble salts and finely divided solid matter can be satisfactorily prevented by addition of minute quantities of castor oil. Without available theory to account for effect at present, castor oil is preeminently the foaming preventative. In carrying out more than 100 laboratory-scale experiments, following materials were tried: (a) *Insoluble Materials.* Pumice, sulfur, pyrolnsite, bone block, lead sulfide, boiler scale, precipitated calcium carbonate, and limestone. (b) *Soluble Inorganic Salts.* Carbonates and sulfates of sodium; chlorides of sodium, potassium, and calcium; hydrochloric acid; potassium dichromate. (c) *Soluble Organic Substances.* Sugar, burnt sugar, extract of leaves and twigs, alcohol, acetone, acetic acid. [In connection with this article covering laboratory experiments it is recommended that the reader refer also to article by Dr. R. E. Hall, Carl Fischer and Geo. W. Smith, appearing in Iron and Steel Engineer, June 1924, covering theoretical discussion, and supplemented by actual results in power plant. Details are given covering methods of control whereby various troubles such as scale formation, foaming, and wet steam may be eliminated. Reprints are obtainable from The Hagan Corporation, Pittsburgh, Pa., or from Dr. R. E. Hall, Bureau of Mines, Pittsburgh, Pa.—Abstr.].—*Linn H. Enslow.*

Effect of Environment on Bact. Typhosum. Chas. A. Stuart. Jour. Bact., 9: 6, 581, November, 1924. In differentiating *Bact. typhosum*, physiological reactions which remain unaltered under conditions that affect every other character of the species are most to be relied upon. Power of growth is very different for different strains and morphological variation seems to be determined by composition of medium and temperature at which grown. Temperature determines consistency of growth. Variations in any characteristic, other than consistency of growth, shown by a single strain cannot be considered as indicative for whole species. Variation, no matter how great, in any one character of strain, does not imply variation in all its characters. From previous environment strain may gain certain momentum which will for a short time determine character of its reaction in new environment. But all strains in all environments are constant in their physiological reactions, which therefore are most to be relied upon for purposes of differentiation. Ten different strains, representative of feces, urine, blood and bile, taken at various periods, from a few days to three years, previous to the investigation were carried through comparative experiments. Strain isolated from feces five months previously was selected as most characteristic for final experiments.—*Linn H. Enslow.*

The Buffering Capacity of B. Coli—The Effect of Some Electrolytes on. J. H. Shaughnessy and I. S. Falk. Jour. Bact., 9: 6, 559, November 1924. Bacteria possess mechanism for regulation of acidity in fluids in which they are suspended, commonly known as "buffering capacity." That of *B. Coli* when measured is found to be significantly large in water and certain salt solutions. The bacterial cell in neutral solutions is electronegative to water and especially reactive with electropositive ions. When menstruum is rendered acid, electonegativity of cell is reduced and its reactivity with sodium or calcium ions, as evidenced by depression of buffer ratio, is more marked in

neutral or alkaline than in acid solutions. Calcium or sodium chloride in non-toxic concentrations will appreciably depress buffering capacity of B. coli although its viability may be maintained. In distilled water buffering capacity of *B. Coli* is greatest in optimum zone of viability (pH 6 to 6.9), and is also significant throughout the range pH 4 to 10. In sodium chloride solutions (0.0725 M to 1.450 M) buffering capacities were reduced, and in calcium chloride solutions (0.0145 M to 0.290 M), practically abolished, in all concentrations non-toxic to the organism, viz; not above, 0.725 M for NaCl or 0.145 M for $CaCl_2$. CaCl of 0.145 M was found to depress buffer ratio more than a five-fold greater concentration of sodium chloride.—*Linn H. Enslow.*

The Use of Sodium Chloride as a Standard in Analysis of Sea Water.. MLLE. Y. MÉNAGER. Comptes rendus, **179**: 195–8, 1924. NaCl content has been used as means for comparison of salinity. Determination is made volumetrically and reported in terms of NaCl per kilogram of sea water. Corrections for temperature and density are necessary. Sea water taken in Atlantic between Faro and Iceland and diluted to uniform titer with normal sea water of Hydrographic Laboratory at Copenhagen has been used as standard. Samples from Gulf of Gascony have been compared against normal sea water of Copenhagen.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Studies on the Waters of the Glaciers of the Massif of Mont Blanc. D'ARSONVAL, BORDAS, AND TOUPLAIN. Comptes rendus, **179**: 445–7, 1924. Surface waters from glaciers are of great purity, but water from body of glacier is muddy. Water flowing away from glaciers is mixture of these types subject to great variation.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Acidity of Water—Its Measure by the H-ion Concentration. ED. IMBEAUX. Revue d'hygiene, **46**: 964–975, 1924. Determinations important to study of corrosive power are: H-ion conc'n; alkalinity, bicarbonate, carbonate, and hydroxide; free CO_2, or aggressive CO_2.—*Jack J. Hinman. Jr.* (*Courtesy Chem. Abst.*)

Cholera in Bagdad. T. BARRET HEGGS. J. Trop. med. and hyg., **27**: 85–91, 1924. Rev. d'hyg., **46**: 1017–1018, 1924. Epidemic of August 1923 started at Abadan on Persian gulf. Mortality was 64.3 per cent. Spread was due chiefly to contaminated water and to carriers. Total cases 168. Of 7,058 persons inoculated with heated emulsion of bacteria, 12, or 1.4 per 10,000, contracted disease. Of 172,942 unvaccinated persons in the city of Bagdad 153, or 8.8 per 10,000, were attacked.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Sanitation of Watering Places for Animals. A. GRAU. Revue de Zootechnie, **2**: 275–277, April, 1923. Aqueous cachexia of sheep may be transmitted to cattle by pond water, or by parasites of aquatic vegetation. Glanders, tuberculosis, and foot and mouth disease may be transmitted by contaminated waters. Water supplied to animals ought to be pure, limpid, and constantly renewed. Ponds are often very dirty; they should be cleaned once a year, and shore cleared of vegetation, in order to get rid of certain

parasites. Use of coagulants, potassium permanganate, or chlorine, is advised.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Flood Flow Characteristics. C. S. Jarvis. Proc. Amer. Soc. Civ. Eng., 50: 10, 1545–81, December, 1924. These are briefly stated. Available data that seemed reliable and valuable have been listed and plotted. First storms that fall after period of drought may yield high percentage of run-off, owing probably to resistance of parched and dusty surface to penetration. Run-off variants are due: (1) to presence or absence of vegetation; (2) to surface texture and condition; (3) to sudden thaws; (4) to capacity of bank and flood-channel storage; (5) to direction of travel maintained by prevailing storms; (6) to altitude, annual rainfall, special topographic or meterological features; and (7), to area, shape, and slopes of drainage basin. Extreme rainfall and run-off rates for practically all regions of United States are nearly identical, affording common basis for estimates. On most American streams, records are altogether too meager to establish fair approximation to maximum flood to be expected in century; or even in period of two decades. Method of attack is explained by which problems in several Central and Western Districts have been solved satisfactorily as regards prevention of floods and protection of property. Among variety of data, location, area, and maximum observed run-off for 978 drainage areas are given.—*John R. Baylis.*

Stainless Chromium Steels. W. H. Hatfield. Chem. and Met. Eng. 31: 14, 544–6, October 6, 1924. Non-corrosive properties of stainless chromium steels are due to chromium being present in sufficient quantities. Addition of nickel to chromium steels imparts increased resistance towards sulphuric and hydrochloric acids; addition of chromium to nickel steels increases resistance towards nitric and hydrochloric acids. Article deals largely with steels containing from 12 to 16 per cent of chromium. Lists are given, both of solutions towards which such steel is satisfactority resistant, and of those towards which it is not.—*John R. Baylis.*

How One Industry Concentrates its Research. Duff A. Abrams. Chem. and Met. Eng. 31: 14, 539–42, October 6, 1924. Structural Materials Research Laboratory of Chicago, organized 10 years ago for studying fundamentals of cement and concrete, is now employing about 40 workers and conducting about 45,000 tests annually. Portland Cement Association joined Lewis Institute of Chicago in its establishment. Staff was charged with one duty—to find out as much as possible about concrete. Results from 100,000 tests, extending over period of 4 years, show that strength secured from cement is primarily dependent upon quantity of mixing water. United States Department of Commerce has announced that broad and scientific investigation of constitution of portland cement is to be undertaken in conjunction with Structural Materials Research Laboratory. Colorimetric test for organic impurities in sand has been developed.—*John R. Baylis.*

Swimming Pool Standards—Uniform and Practicable Regulations. Arthur M. Crane. Nations' Health, 6:2 99, February 1924. Regulations of different

states show wide difference of opinion regarding operation and construction features, etc. Quantity of water per bather ranges from 400 to 2000 gallons. Several states limit weekly bathing load to 20, on fill and draw pools. This is equivalent to 50 gallons per bather.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Outdoor Swimming Pools. Stanley Pinel. Bulletin no. 61, Eng. Ext. Dept., Iowa State College, January 23, 1924. Design, construction, operation, life saving and other safety measures, and methods of filtration, disinfection and algae treatment are discussed.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Preliminary Data Required for the Intelligent Design of a Water Purification Plant. C. Arthur Brown. Southwest Waterworks Journal, 5: 13, April, 1924. Graphic curve of past, present and deductive future population; post office receipts; bank deposits; income of water department; water consumption; data on water in use, and on characteristics of other available supplies; data on location and construction of intakes, location and construction of sewers, sites for purification system; ascertain attitude of community as a whole toward project; data and tentative plans to permit of future enlargements; data on cost of construction, maintenance and operation.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

The Silting of the Lake at Austin, Texas. T. V. Taylor. Southwest Waterworks Journal, 5: 12, March 1924. New lake has shown that between 1913 and 1922, 84 per cent of the capacity has been taken up with silt.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

The Control of Oil Pollution in Rhode Island. Stephen DeM. Gage. Jour. Boston Soc. Civ. Eng., 2: 6, 237, June, 1924. Damaging effects of oil pollution are destruction of fish and game, fire hazard on waterfront, destruction of usefulness of beaches, and claimed contributory cause of skin eruptions and similar troubles among bathers. A suggested means of preventing oil pollution from vessels has been to discharge oil laden water ballast to separators ashore after vessel has been docked. Work is also being done in the devising of oil separators suitable for use on vessels. Waste-waters of all kinds from oil distillation and refining plants must pass through oil separators before being discharged. Rules and regulations for prevention of oil pollution are given.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Public Health of Jersey City. Hugh A. Kelley. J. A. A. for Promoting Hygiene and Public Baths, 4: 17, 1924. In addition to two public baths, nine public schools in Jersey City have swimming pools. Pools are cleaned and refilled weekly.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

A Practical Method for the Chlorination of Water at Bathing Places. Majors W. P. Baker and P. E. McNabb. Jour. A. A. for Promoting Hygiene and Public Baths, 4: 22, 1924. Washington, D. C. disinfects public bathing pools

by application of chlorine from apparatus installed on a motor boat. Daily analyses during 100 days bathing season show total bacterial count reduced from 175,000 in raw water entering basin to less than 100 cc. near beach. Total cost less than $50.00 per day, or less than 2 cents per bather.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Scraping Water Mains, Helensburgh, Scotland. Jas. W. Stirling. Surveyor, 65: 1691, 554, June 13, 1924. Town pipes scraped by hand, 85 yards in each direction being dealt with from one opening, at approximate cost of 3d. per yard per inch in diameter. Scraping more than doubled the discharge from certain hydrants.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Variations in Consumption of Water in Towns. John Bowman. Surveyor, 65: 1693, June 27, 1924. Per capita consumption of water in 58 areas in Great Britain with comparative statistics for American Cities. Consumption ranges from 14.26 to 70 gallons per day.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Water Supply Questions. John Chisholm. Surveyor, 65: 1691, 349, June 13, 1924. Progress in water purification and in administration and construction is reviewed, and suggested amendments to water works law summarized.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Abingdon (Eng.) and some of its Municipal Undertakings. Raphael V. Hall. Surveyor, 65: 1689, 515, May 30, 1924. Main supply is obtained from water-bearing formation underlying the district. Tunnels have been constructed linking up the pockets in the honeycombed rocks providing storage capacity of 125,000 gallons.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Municipal Work in Hyde, Cheshire, Eng. James H. Ward. Surveyor, 65: 1688, 493, May 23, 1924. Domestic supply obtained from Manchester Corporation at a cost of 3d. per 1000 gallons up to 91¾ millions and 6d. per 1000 above that quantity.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Reading and Its Municipal Undertakings. A. S. Parsons. Surveyor, 65: 1680, 319, March 18, 1924. Water supply obtained from River Kennet, through two plants. One consists of "Walker" pre-filters followed by sand filters, the effluent treated with 0.5 p.p.m. chlorine. Second plant is similar with exception that prefiltered water is passed through pressure filters.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Transactions, Second Annual Conference, National Coast Anti-Pollution League, October 1–3, 1923. Transactions contain detailed and valuable discussions on the effect of oil pollution on the seacoast, on fish, bathing beaches and resorts, health and navigation; means of preventing oil pollution as practiced in United States and England; pollution of inland waters by tannery, mine and other wastes. Legislative and legal aspects of pollution conditions are considered fully.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Storage and Distribution of Water on Ships. A. E. Wadsworth. Melbourne, Australia, Quarantine Service Publication, No. 14. Lack of organized effort has caused water on ships to receive less attention than shore supplies and scarcity of literature on the subject shows this phase of hygiene has been neglected. Mains furnishing water to vessels are usually at low points in the system, often near dead ends, causing a water high in suspended matter in many cases. Excellent suggestions for improvements of ship's water supplies.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Government Control of Pollution. C. A. Emerson, Jr. Engineers and Engineering, **41**: 1, 11, January 1924. Diversified legislation in various states and lack of any general federal legislation unifying procedure in control of pollution are pointed out. Author believes the policy of "River Boards" or "Joint Commissions," as provided in England, which have complete jurisdiction over a particular watershed, would be applicable to American conditions.—*A. W. Blohm.* (*Courtesy U. S. P. H. Eng. Abst.*)

Tests for Corrosibility of Water. J. W. Ledoux. Eng. News Record, **93**: 861, 1924. Test is made by placing water in 2-ounce bottle with given amount of pure Fe and determining Fe absorbed after exposing sample with Fe for 20 minutes at 300°F.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Features of New Water Filtration Plant at Richmond, Va. Wellington Donaldson. Eng. News-Record, **93**: 623, 1924. Plant has 30 m.g.d. capacity, is built inside old coagulating basins, and treats water from James River subject to sulphite waste pollution. It is of mechanical filtration type with mixing chambers, coagulating basins, and provision for aeration.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Philadelphia Advised to Spend $99,000,000 for Water. Anon. Eng. News Record, **92**: 968, 1924. Recommendations designed to provide Philadelphia with 500 m.g.d. water supply in 1975 are outlined.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Chlorinated Overflow Storm Sewage to go into Water Reservoir. Anon. Eng. News Record, **92**: 973, 1924. Springfield, Ill., organized sanitary district and plans new water supply and sewage treatment plant.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Water-Borne Diseases Epidemic in South Pasadena. Anon. Eng. News Record, **92**: 1018, 1924. Epidemic was traced to sewer leakage entering low pressure water pipe.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Water Borne Typhoid at Ramsay, Michigan. Anon. Engr. News Record, **92**: 1105, 1924. Thirty-two cases of typhoid were attributed to use of badly polluted river water.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Sand Studies at Montebello Filters. Baltimore. ABEL WOLMAN, S. T. POWELL, JOHN R. BAYLIS. Eng. News Record, 92: 1094, 1924. Wolman and Powell hold that sand size is cause of trouble in filters. Baylis rejoins that coarse sand is not always effective in eliminating filter troubles.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Rules Prohibiting Cross-Connections in State of Washington. ANON. Eng. News Record, 93: 62, 1924. All cross connections with unapproved supplies are prohibited.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Alum Agitation Studies at Reading, Pennsylvania. CHARLES R. COX. Eng. News Record, 93: 101, 1924. Importance of continuation of mixing of alum in turbid waters after initial diffusion has occurred to provide contact between forming aluminum hydroxide floc and clay and bacteria in colloidal suspension is shown. Fifteen minutes mix at 0.5 to 0.6 feet per second average velocity is adequate for Reading conditions.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Chlorine Control at Wilmington Filter Plant. W. COMPTON WILLS. Eng. News Record, 93: 148, 1924. Hourly ortho-tolodin tests for residual chlorine are made and artempt is made to keep residual chlorine between 0.06 and 0.10 p.p.m.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Producing Artificial Ground Water at Frankfort, Germany. DR. SCHEELHAASE, GORDAN M. FAIR. Eng. News Record, 93: 174–76, 1924. Highly polluted water from River Main is put through scrubbers and slow sand filter from where it enters exfiltration gallery and is allowed to percolate into sandy soil to increase ground water supply. Progressive mineralization of organic material in water as it passes through ground was determined on test wells by oxygen consumed test. Excellent supply of 2.1 m.g.d. was obtained at ground water pumping station 1640 feet away from exfiltration gallery.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Second Water Purification Works for Oklahoma City. ANON. Eng. News Record, 93: 216–19, 1924. Description of new clarification, softening, aeration, and carbonization plant is given.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

First International Sanitary Engineering Conference. HARRISON P. EDDY. Eng. News Record, 93: 342–345, 1924. Short review of papers on Administration of Health and Sanitary Services, Activated Sludge, Sewage Treatment in General, Sewerage Practice, Water Supply and Treatment and Garbage and Refuse Collection and Disposal is given.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Principles of Four Kinds of Flow in Settling Basins. WYNKOOP KIERSTED. Engr. News Record, 93: 346–47, 1924. Effect on sedimentation in straight-line, radial, rotary, and spiral inward flow basins is discussed.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Water and Sewerage Construction of State Institutions by Maryland Department of Health. George L. Hall. Eng. News Record, 93: 491–94, 1924. Work of State Bureau of Sanitary Engineering in designing and building water supply and purification plants and sewerage systems and sewage works for state institutions is described.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Corn Products Water Supply and Underground Pumps. Anon. Eng. News Record, 93: 501–3, 1924. The 3.5 m.g.d. supply has pumping station 357 feet underground connected to system of ten wells 1300 to 1500 feet deep.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Operation of Slow Sand Filters at Hartford, Conn. Caleb Mills Saville. News Record, 93: 508–09, 1924. Plant filtered 4.54 m.g.d. per acre with average color removal of 41.7 per cent at cost of $4.61 per million gallons.—*Frank Bachmann.* (*Courtesy Chem. Abst.*)

Report of Committee on Water Works and Water Supply. George W. Fuller, Chairman. Proc. Amer. Soc. Municipal Improvements, pp. 26–31, 1923. In very brief report committee calls attention to items of recent occurrence in water works field. Discussing report, P. H. Norcross called attention to increased demand for water which is pure and inviting to the eye.—*John R. Baylis.*

Water Supply Works at Memphis. F. G. Cunningham. Proc. Amer. Soc. Municipal Improvements, pp. 41–59, 1913. City is constructing, at cost of $2,800,000, water supply which includes system of drilled wells, treatment plant, pumping station, and storage reservoir. Wells are drilled to stratum of sand known as LaGrange formation, which is reached at depth of from 300 to 450 feet. Only marked objectionable constituents of underground water are iron and carbon dioxide. Iron varies from 0.2 to 6 parts per million, and carbon dioxide from 90 to 130. Station, treatment plant, and wells will have average daily capacity of 18 million gallons. Water is to be raised to surface by air-lift. Much carbonic acid will be removed in this manner, but water will be aerated before passing to filters.—*John R. Baylis.*

Public Baths and Comfort Stations. Harry F. Bascom. Proc. Amer. Soc. Municipal Improvements, pp. 7–13, 1923. Public baths promote health of locality. A number of small baths distributed over city are better than one or two large stations. They should be under control of local board of health. Type of station should depend upon local conditions; first utilizing natural bathing places such as ocean beaches, rivers, and small streams. Next choice is artificial pools. Street showers have been used in number of cities in warmer months. No city should be without one or more public comfort stations.—*John R. Baylis.*

Metropolitan Water Board. 18th Annual Report on the Results of the Chemical and Bacteriological Examination of the London Waters for the Twelve Months ending 31st March, 1924. Sir A. C. Houston. Sixteen sections are

included, chief of which are: Chlorination, super-chlorination and de-chlorination, resistance to filtration and microscopical appearances of pre-filtration waters, rapid sand filtration experiments at Barn Elms, gulls as sources of B. Coli contamination of water, taste of chlorinated waters, complaints from consumers medicated waters, and meterological notes. Introduction is literary and historical discussion of sources of supply, and of various stages of purification and treatment during past eighteen years. *Chlorination of raw Thames water prior to filtration.* 24,277 million imp. gallons were treated, average dose being 1 in 2.42 millions, showing an estimated saving of approximately $70,000 as against cost of pumping and retaining water in storage reservoirs. Bacteriological results were likewise better and there were no complaints as regards taste. New River water was treated with chlorine to remedy bacteriological deterioration of water during winter floods, 5,237 million imp. gallons receiving average dose of 1 in 3.07 millions without giving rise to taste. In general, greatly increased purification of raw water is reported. Brief reference to *super-chlorination and de-chlorination* emphasizes fact that even with very short period of contact, sterilisation can be effected without taste resulting. Disadvantages are cost of treatment, which in some cases may be prohibitive, and need for careful supervision. Details of taste in one supply after treatment are given. Water had been previously treated with excess chlorine without taste resulting. *Resistance to filtration experiments and microscopical appearance of pre-filtered* waters are described in detail. Emphasis is laid upon importance of determining nature and amount of suspended matter, its relationship to production of taste, and its effect on filtration generally. Organisms which have worst blocking effect on sand filters are chiefly asterionella, fragillaria, cyclotella, and stephanodiscus; others like oscillaria and ceratium do not usually interfere seriously with filtration, although present in large numbers. Considerable space is devoted to *pre-filtration waters*, it being held that 'the pulse of the metropolitan water supply is the condition of the pre-filtration waters'. In dealing with laboratory technique, reference is made to fact that post-war chemical salts (bile-salts), used in colon test, were found greatly inferior to those of pre-war period, an important consideration when studying quality of water. Extensive chemical and bacteriological figures clearly show great improvement in quality of raw water as result of storage or pre-chlorination. All waters previous to sand filtration have been brought into condition of considerable, if not remarkable, purity. Great mass of pre-filtration water was improved at least 10 times, some 100 times, and small amount 1000 times, as judged by B. coli tests. Primary rapid sand filters, constructed at Barn Elms, nine in number, were built as experiment to save construction of new and costly slow sand filters, by using rapid filters for removing suspended matter and algal growths, thereby enabling increased rates of filtration through existing slow sand filters. Figures for first year's run show experiment to be entirely successful. Three slow sand filters operated at increased rates of 54, 47, and 50 per cent respectively upon effluents from primary filters, showed 88.9, 85.7 and 88.5 per cent respectively, freedom from B. coli in 100 cc., as compared with 73.1 per cent from West Middlesex works as a whole. As judged by laboratory tests, rapid sand filters did excellent work in removing most of growths and

suspended matter generally, resistance to filtration experiments indicating over 100 per cent improvement. Figures are supported by convincing photographs. In spite of increased rates of filtration the slow sand filters were cleaned only 4, 3, and 3 times respectively during twelve months. *Gulls.* Houston emphasizes fact that so far as is known, gulls do not suffer from water borne diseases pathogenic to man. Their droppings constitute however embarrassing form of excremental pollution, which in light of present knowledge, cannot be differentiated from that of human origin. Experiments in frightening gulls away by frequent firing of blank cartridges met with considerable success. *Visitors.* "All the year round engineers, chemists, and bacteriologists from home and all four quarters of the globe are constantly visiting the Board's works and laboratories, and are given every facility for pursuing their investigations. We certainly learn much from their visits by interchange of ideas, exchange of reports and so forth, and we can only hope that they sometimes carry away with then something in return. Our visitors are of all ages, but, after all the keynote to future progress lies in the hands of the comparatively young." By those who have been privileged to count themselves among Sir A. C. Houston's visitors, this generous comment will be greatly appreciated. Discussion relative to *taste in chlorinated waters* is particularly valuable. Taste cannot be measured; latent taste may become active by some slight alteration in conditions. Three distinct tastes are described, chlorinous, iodoform (chemical), and "indeterminate" which may include earthy, mouldy, damp straw, and bricky. Untreated waters may have some of these latter tastes, but usually it requires presence of chlorine to draw out their characteristics. Chlorinous taste is usually caused by excess of chlorine and can be removed by super-chlorination and de-chlorination methods. Only danger to superchlorination form of treatment for taste prevention is in lack of boldness in pushing treatment far enough, Boldness is held to be best antidote to taste troubles. Permanganate does not remove chlorinous taste and may make it more pronounced. Iodoform taste is produced by action of chlorine on substances about which little is known. It may be produced artificially in laboratory and occurs in waters high or low in organic matter. Permanganate can usually be relied upon to prevent its formation, or to remove it; it can be added before or after chlorination, and either before or after filtration. If permanganate has been used up and water still contains free chlorine, latter may apparently act upon fresh substance to produce iodoform taste again. If permanganate added previous to, and chlorine, after filtration, iodoform taste may result. That is, permanganate apparently cannot under these conditions so alter a water as to prevent, or remove iodoform taste; but if de-chlorination is practised, there is no taste of chlorine. As regards "indeterminate" taste, difficulty may be experienced because of its similarity to those which occur in untreated waters. They are neither so common, nor, perhaps, so objectionable, as iodoform taste and although some of them can be removed, or obviated, in much the same way, it must be confessed that others are of a most intractable character. London works were not designed for post-filtration chlorination methods, and, generally speaking, therefore, ante-filtration processes are alone admissible; but there are certain advantages in chlorination subsequent to filtration. If carried out before

filtration filter beds may be unsuspectedly adsorbing taste-imparting materials, with production subsequently of long drawn out train of taste troubles. If treatment is carried out subsequent to filtration there is no aftermath. Susceptibility of certain waters may control whole situation. Although we have gradually gained most valuable experience, further knowledge is urgently needed. Included in this section is valuable table showing superchlorination, de-chlorination, permanganate, and SO_2 treatment in dealing with taste prevention and removal. Two pages devoted to *complaints from consumers* will be found of considerable interest to water engineers and superintendents. Under *medicated waters* special reference is made to application of sodium iodide. Resumé and discussion of subject concludes "writer is far from being out of sympathy with the Rochester experiment for he feels that if there are really any risks they may very easily be greatly exaggerated, and if there are no tangible risks, in what other practical way can potential sufferers from thyroidism be forced, willy nilly, to undergo treatment with a drug which a consensus of opinion agrees is of definite prophylactic importance?" Report concludes with exhaustive tables showing complete chemical, bacteriological and physical data of London supply; meterological notes; and graphs, charts, and beautiful photographs of plankton life. The 18th annual report contains much new information and will be found of great value to all interested in art of water purification.—*Norman J. Howard.*

NEW BOOK

Tables and Memoranda ("Clarke's Tables") for Plumbers, Builders, Sanitary and Electrical Engineers. J. W. Clarke. With new series of electrical tables and memoranda by E. C. Roche. B. T. Batsford, Ltd. 2s. 2d. 330 pp. Munic. Eng., 73: 390, 1924. Review.—*R. E. Thompson.*